BAMBOOS OF MEGHALAYA

By

Dr. H.B. Naithani

Forests and Environment Department
Government of Meghalaya
Shillong

BAMBOOS OF MEGHALAYA

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सत्यमेव जयते



Message

The State of Meghalaya, due to favourable environmental factors, physiographical features and geographical location, has a rich and diverse vegetation. This includes enormous stock of bamboo forests with diverse species which the State is endowed with. Its abundance in varied uses has led this species to play an important role in socio-economic and cultural life of people of the Sate. Undoubtedly, bamboo is one of the important crops that provides livelihood options to many people of our State. Bamboos include some of the fastest growing plants of the world which are exploited for its potential and effectiveness in traditional structure of houses, bamboo crafts, curvings and other uses. It has the ability to combat climate change by way of carbon sequestration, carbon sink and is effective in controlling soil erosion in the hills. They also create an ecosystem to provide the habitats and food for birds and other animals.

Bamboo forests in the State are mostly wild, with very little or no scientific management. Sustainable management of bamboo forests of the State is imperative, so that this vital resource is preserved, nurtured and improved.

I am delighted to see that the Silviculture Division under the Climate Change, Research & Training Wing of the Department of Forests & Environment, Meghalaya has taken the initiative of documenting and compiling the book "***Bamboos of Meghalaya***".

I congratulate the author for his commendable effort in research and contributuion which has led to this valuable publication. I am sure the book will be of immense use to the academicians and various Stake-holders and would serve as a useful reference.

Shri Conrad Kongkal Sangma
Hon'ble Chief Minister of Meghalaya

सत्यमेव जयते



Foreward

I would like to congratulate Climate Change, Research & Training wing of Department of Forests & Environment, Meghalaya for bringing out this remarkable compilation titled "***Bamboos of Meghalaya***".

Bamboo and its products due to its varied use have enormous economic potential for uplifting the socio-economic life of many people in our region. No other plant material can rival the utility of bamboo. It requires little maintenance during its growing and production cycle and can occupy the same ecological niche as that of trees.

Bamboo being a fast growing plant offers livelihood to many people. Considering the increasing demand of bamboo and its products worldwide, it is a viable alternative to timber. It is also well suited for an effective control of erosion, reduces runoff, sustains riverbanks and helps mitigate water pollution. I would like to commend the author of this book for meticulously gathering the data and compiling the book which provide details of each species of Bamboo that is found in our State ranging from its distribution, use, economics, threats and management.

I appreciate the work done by Silviculture Division under Climate Change, Research and Training Wing, Department of Forests & Environment, Meghalaya. This publication will surely serve as an excellent guide for foresters, researchers, students and other stake-holders.

Shri. James. P. K. Sangma
Hon'ble Minister of Forest & Environment Department
Government of Meghalaya

सत्यमेव जयते



Foreward

It gives me immense pleasure to take note that the Climate Change, Research and Training Wing under the Forest & Environment Department has undertaken a study to feature one of the main forest crops of the State. This book captures the importance of Bamboos and its significance, documented through the efforts of research by Dr. H. B. Naithani.

Bamboos grow extensively throughout the State and it has been part of the socio-economic life of the people. It also serves as the main source of livelihood for many. It is fast growing and requires very low maintenance. It is used as an alternative to timber which is cost effective and also offers other environmental benefits.

The book is comprehensively compiled and illustrated, covering a wide range of topics viz. distribution, uses, market potential, conservation strategies, sustainable management, silviculture, regeneration and propagation, nursery and plantation techniques of bamboo.

I would like to commend the author for his exemplary effort in documenting the details of all the bamboo species that are found in the State of Meghalaya. I would also like to place on record my appreciation for the works carried out by the Climate Change, Research and Training Wing of the Department of Forests & Environment. This publication supported by the Department will surely serve its purpose of being an invaluable guide for foresters, researchers, students and other stake-holders.

(M.S. Rao, IAS)
Chief Secretary
Government of Meghalaya

सत्यमेव जयते



Foreward

Meghalaya is endowed with a bountiful wealth of natural forest and resources. This book on "Bamboos of Meghalaya" focuses on many information about its distributuion, scope and uses, sustainable management and harvesting of Bamboos found in the State and will serve as a valuable document for guiding foresters and environmentalists to identify, understand and utilize the natural resources sustainably.

I would like to commend the Silviculture Division under the Climate Change, Research & Training Wing of the Forests and Environment Department for publishing this book which provides the profile of various aspects of Bamboos that need scientific management as they are significant part of the diverse forest genetic resources of the State.

Bamboos are intrinsically linked with the livelihood of the local people. There is an immediate need to understand the floristic diversity of the Bamboo for their sustainable utilization. This book will become a handy guide for researchers, botanists students and other stake holders.

I wish to congratulate the author for the excellent documentation and timely publication of this important volume.

(D. P. Wahlang, IAS)
Principal Secretary,
Forest and Environment Department,
Meghalaya, Shillong

सत्यमेव जयते



Foreward

I am delighted to see that the Silviculture Division under the Climate Change, Research & Training Wing of the Forests and Environment Department has undertaken to publish this book titled "***Bamboos of Meghalaya***".

Bamboo is extensively grown in Meghalaya and the socio-economic life of many people revolves around the varied uses of bamboo and its products. Bamboo, being a fast growing and high yielding plant does not require high maintenance and offers livelihood to many people in the region. Considering the increasing demand of bamboo and its products worldwide, it has an enormous economic potential and is a viable alternative to timber. The characteristics of Bamboo makes it a perfect solution to the environmental and social consequences of tropical deforestation. Its biological characteristic make it a perfect tool for solving many environmental problems, such as erosion control and carbon dioxide sequestration.

This book is comprehensively written and well-illustrated with beautiful photographs. It covers topics relevant to the distribution, uses, marketability and economics, the scope of bamboo craft in the state, strategies for conservation and sustainable utilization of bamboo, its harvesting, flowering and mortality, regeneration and propagation, nursery and plantation techniques which needs to be commended.

I congratulate the author for the excellent documentation of this important volume and its timely publication. This book will undoubtedly be of immense use to the field functionaries, students and various other Stake-holders.

(Y.S. Shullai, IFS)
Principal Chief Conservator of Forests & HoFF
Meghalaya, Shillong

सत्यमेव जयते



Foreward

Meghalaya has rich forest eco-system with varied forest types and vegetation which hold rich biological wealth. Among the plants, bamboo is a very fast growing, renewable and an easy to grow resource which is an extremely versatile material with endless uses including construction, food and fuel.

Bamboo is the fastest growing, highest yielding renewable natural resource. It is not only an ideal economic investment that can be utilized in many different ways but it also has huge potential for alleviating many problems both social and environmental. On account of extensive shallow rhizome-root system and accumulation of leaf mulch, bamboo serves as an efficient agent in preventing soil erosion and conserving moisture, reinforcement of embankments and drainage channels. Additionally, its qualities of strength, light weight and flexibility make it a viable alternative to timbers. In fact, bamboo possesses a great potential either in water conservation, soil erosion control, land rehabilitation and carbon sequestration, which is supposed to give it a promising future.

I appreciate the efforts taken by the Silviculture Division under Climate Change, Research & Training Wing, Forests & Environment Department, Meghalaya in bringing out this publication titled "***Bamboos of Meghalaya***". This book provides key identification characters, its utility, threats and management aspects of Bamboo species found in Meghalaya that would fulfill the need and serve as an excellent guide for foresters, conservationists, students, researchers and other stake holders.

I take this opportunity to complement the author for bringing out this valuable publication. I hope that this book will be use by various stakeholders and serve as a ready reference.

(B.S. Kharmawphlang, IFS)
Principal Chief Conservator of Forests (CC, R&T)
Meghalaya, Shillong



ABOUT THE AUTHOR

Dr. Harsh Bardhan Naithani is a retired Scientist from Botany Division, Forest Research Institute, Dehradun. At present serving as Expert Scientist in Botany Division, F.R.I. Dehradun. He has travelled widely spanning Ladakh in the North to Indra Point, Gt. Nicobar, in the South and from Kibitho in the East (Anjaw district of Arunachal Pradesh) to Goa in the West in connection with floristic studies. He has 17 books and 200 scientific papers in journals of national and international repute. He received training in Forest Tree and Technology and Seed Radiology Workshop at Mississippi, State University USA as FAO fellow. He has guided seven research students for their Ph.D. He possesses 15 year teaching experience of Systematic Botany to IFS Probationsers at Indira Gandhi National Forest Academy, Dehradun; to State Forest Service Trainees of CASFOS, Dehradun and M.Sc. Forestry, M.Sc. Plantation Technology, Diploma Biodiversity Students in Forest Research Institute University, Dehradun. Recently in 2017-2019 four book entitled Study on Qualitative and Quantitative Survey of Invasive Species in Dehradun District was published by the Biodiversity Board, Uttarakhand jointly with Dr. Rakesh Shah, Chairman Biodiversity Board and Sri S.S.Rasaily, Member Secretary, Biodiversity Board. Trees of Tollygunje, Kolkata, Forest flora of Uttar Pradesh and Floral Wealth of Valley of Flowers National Park, a World Heritage Site are other notable publications made with Uttarakhand Biodiversity Board.

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One of the author Dr. H.B.Naithani is extremely thankful to Dr. Subhash Ashutosh, IFS Principal Chief Conservator of Forests, Mr. K.S. Lyngdoh, IFS, Chief Conservator Forest for the overall support in completion of this assignment. To Dr. N.S.Bisht, Principal Chief Conservator of Forests (Retd.) for suggestion. My special thanks to Mr. P. Kharbuli, Range Officer of Silviculture Division who took keen interest throughout the study and accompanied me during the field tours of East Khasi Hills, Ri Bhoi and Jaintia Hills Districts; also to Mr. L.T. Ao, Assistant Conservator Forest for Garo Hills for accompanying and providing all the necessary help in Garo Hills and West Khasi Hills Districts. My special thanks are due to Mr. Ponison A. Momin, Forester; Mr. Beathenson Momin, Forest Guard; Mr. Biru Rana, Plantation Mali, Mr. Watenson Marak, Plantation Mali, Mr. John Sangma, (M. Roll) for excellent field work carried out by them. Last but not least, I thank Mr. Maxwell Khongiong who drove the jeep with great patience throughout the tour.

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INTRODUCTION

One of the seven sister states of the North-Eastern Region of the country, Meghalaya has an area of 22,429 km2 (0.68% of the country's geographical area). It lies between 25° 00' and 26° 10' N latitude and 89° 45' to 92° 45' E longitude. There are eleven districts in Meghalaya viz. East Garo Hills, West Garo Hills, South Garo Hills, North Garo Hills, South West Garo Hills, East Khasi Hills, West Khasi Hills, East Jaintia Hills, West Jaintia Hills, Mawkyrawt and Ri Bhoi. It is predominantly a hilly state surrounded by the Assam and Bangladesh plains. The hills rise abruptly in south, while it is gradual in north. The hills in general have an east west orientation. The altitudinal variation range from 150-1950 m with the Shillong plateau at the crest. True to its name Meghalaya is an abode of clouds and thus increased moisture conditions prevail. These hills are dissected and drained by a number of rivers and rivulets draining to north and south. In Garo hills, there are some westward flowing rivers. Some of the important rivers of Meghalaya are Umiam Khwan, Umiam Mawphlang, Umngot, Simsang, Mahadeo, Rongkai, Kolkongkini, Daru, Drong, Kynshi, Ildek, Dudnai, Didak, Jinjiram, Khri, Umtrew, Umkhen, Kupli etc. The Shillong plateau is perhaps the oldest in the north east India.

The State has a population of 2.96 million (0.24% of the country's population), out of which 79.93% is rural and 20.07% is urban. The average population density is 132 persons per km2. In terms of tribal composition, the state has three distinct regions, namely, Garo Hills, Khasi Hills and Jaintia Hills. According the 19th Livestock cenees 2012, the live stock population of the state is 1.95 million.

The soil of Meghalaya differs greatly over different places. They are lateritic in origin and vary from sandy loam, red loam to clayey loam. They are grouped under laterite soil, ferruginous red soil (old or alluvium) mountain and hill soil.

The state enjoys a very salubrious climate. However, the western part covering Garo hills is more hot and oppressive, while the Khasi and Jaintia hills are more cooler. The annual average rainfall varies from about 4000 mm to 11,436 mm. incidentally, the highest rainfall receiving areas in the world viz. Mawsynram and Sohra are located in the state.

The Western part of the State is warmer with mean temperature ranging between 12^0C to 33^0 C. The central upland is relatively cooler with mean temperature ranging from 2^0C to 24^0C. The land use pattern of the state is given in table -1.

Table .1: LAND Use Pattern		
Land Use	**Area in '000 ha**	**Percentage**
Total Geographical area	2,243	
Reporting area for land utilization	2,227	100.00
Forests	948	42.57
Not available for cultivation	226	10.15
Permanent Pastures and other grazing lands	0	0.00
Land under misc. tree crops and groves	160	7.18
Culturable wasteland	393	17.65
Fallow lands other than current fallows	157	7.05
Current fallows	59	2.65
Net area sown	284	12.75

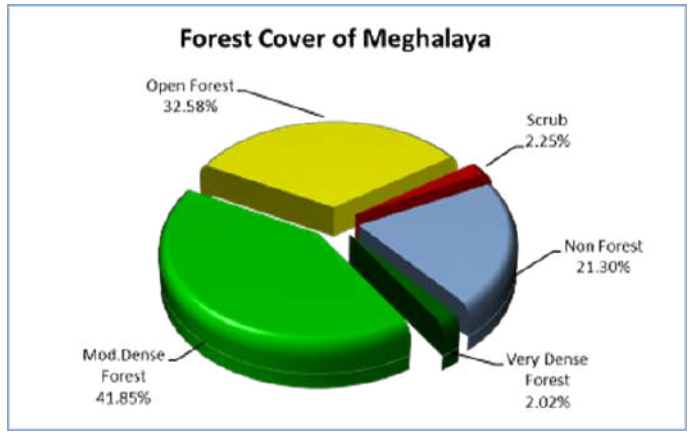
Source: Land use statistics, Ministry of Agriculture, GOI, 2008-2009.

RECORDED FOREST AREA

Forest Cover

Based on interpretation of satellite data pertaining to Oct-Dec 2015, the forest cover in the State is 17,146 sq km, which is 76.45% of the State's geographical area. In terms of forest canopy density classes, the state has 453 sq km under very dense forest, 9,386 sq km under moderately dense forest and 7,307 sq km under open forest category.

Fig:1



(Source: FSI 2017)

Forest Cover in Green Wash Area

The State has a recorded forest area of 9,496 sq km, which is 42.34% of the State's Geographic area. The Reserved, Protected and Unclassed Forests are 11.72%, 0.13% and 88.15%, respectively of the recorded forest area. .Due to non-availability of digitized boundary of recorded forest area from the State, the updated green wash which is 17,562 sq km has been used and the analysis of forest cover within and outside this area is depicted below.

Table .2: Forest Cover within and outside Green Wash

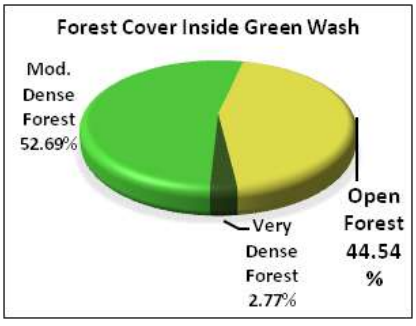
Forest Cover Within Green Wash (area in sq km)	
Very Dense Forest (VDF)	410
Moderately Dense Forest (MDF)	7,791
Open Forest (OF)	6,587
Total	14,788
Very Dense Forest	43
Moderately Dense Forest	1,595
Open Forest	720
Total	2,358

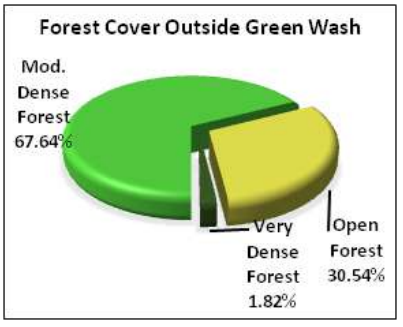
Table .3:

Total Forest Cover	17,146
Tree Cover	657
Total Forest & Tree Cover	17803
Of State's Geographical Area	79.37 %
Of India's Forest & Tree Cover	2.22 %
Per capita Forest & Tree Cover	0.60ha

Source: FSI (2017)

Pie Charts showing forest cover inside and outside Green Wash





Altitude-Wise Distribution of Canopy Density Classes

Table 4: Altitude-wise Forest Cover (area in sq km)

Altitude Zone(m)	Geog. Area	VDF	MDF	OF	Total
0-500	10,152	232	4,192	4,104	8,528
500-1000	6,239	193	2,752	2,271	5,216
1000-2000	6,038	28	2,442	932	3,402
Total	22,429	453	9,386	7,307	17,146

(Based on SRTM, Digital Elevation Model, FSI, 2017)

Table 5: Forest Cover in Different Patch Size Classes.

Sl No.	Patch Size Range (Sq km)	No. of Patches	Area (sq km)	%age
1.	≥0.01 ≤1.0	6,871	398	2.32
2.	> 1.0 ≤ 10	88	224	1.30
3.	> 10 ≤ 100	6	135	0.79
4.	> 100 ≤ 500	0	0	0.00
5.	> 500 ≤ 1000	0	0	0.00
6.	> 1000≤ 5000	1	1,215	7.09
7.	> 5000 ≤ 10000	0	0	0.00
8.	> 10000	1	15,174	88.50
Total	6,967	17,146	100.00	

Source: FSI (2017)

Table 6:Growing Stock

Growing Stock		% Contribution to country
Growing Stock in Recorded Forest Area	38.720 m cum	0.92
Growing Stock in TOF	17.254 m cum	1.08
Potential Production of industrial wood from TOF	0.59 m cum	0.79
Bamboo bearing area within forest area of the state	5943 sq km	3.78
Total number of culms	1323 millions	4.71
Total green weight equivalent of culms	11462 (000' tonnes)	6.07

Source: FSI (2017)

Table 7: District- wise Forest Cover

District	Geo-graphical Area	2017 Assessment				% of GA	Change *	Scrub
East Garo Hills[TH]	2,603	63	1,075	1,128	2,266	87.05	-1	53
East Khasi Hills[TH]	2,748	3	1,012	736	1,751	63.72	6	106
Jaintia-Hills[TH]	3,819	100	1,488	915	2,503	65.54	-64	86
Ribhoi[TH]	2,448	132	1,096	915	2,143	87.54	-2	35
South Garo Hills[TH]	1,887	45	1,014	629	1,688	89.45	-2	12
West Garo Hills[TH]	3,677	0	1,244	1,593	2,837	77.16	-27	67
West Kha-si Hills[TH]	5,247	110	2,457	1,391	3,958	75.43	-26	146
Grand Total	22,429	453	9,386	7,307	17,146	76.45	-116	505

Forest Cover map of Meghalaya (Source: FSI (2017)

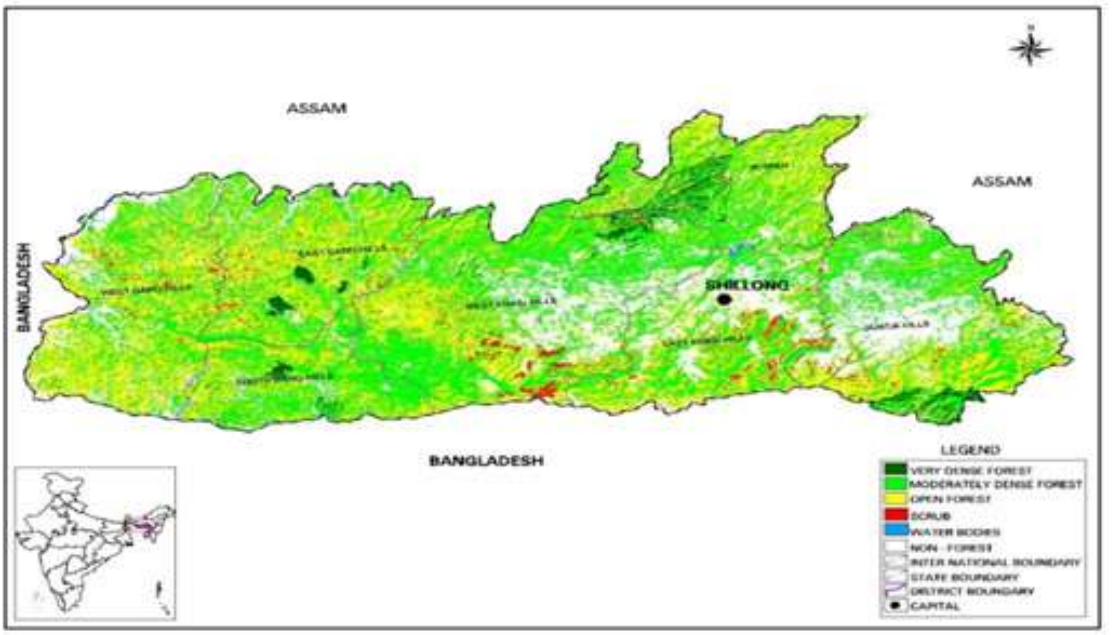


Table 8: District- wise Forest Cover

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West Kha-si Hills[TH]	5,247	110	2,457	1,391	3,958	75.43	-26	146
Grand total	**22,429**	**453**	**9,386**	**7,307**	**17,146**	**76.45**	**-116**	**505**

*Change compared to updated 2015 assessment. **Source: FSI (2017)**

Table 9: Forest Cover Change Matrix (area in sq km)

Class	2017 Assessment					Total 2015 up-dated
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	417	0	0	0	0	417
Moderate-ly Dense Forest	36	9,314	76	44	85	9,555
Open Forest	0	72	7,098	56	64	7,290
Scrub	0	0	89	242	12	343

Non Forest	0	0	44	163	4,617	4,824
Total (ISFR 2017)	453	9,386	7,307	505	4,778	22,429
Net Change	**36**	**-169**	**17**	**162**	**-46**	

Source: FSI (2017)

VEGETATION

Due to favourable environmental factors, physiographical features, geographical location, biotic influence, human interaction, etc. the vegetation of the state is very rich and diverse. They could be broadly grouped based on altitudinal difference as tropical, subtropical and temperate types. These could be further divided into types and subtypes depending upon the locality factors. Though the vegetation is intact in many pockets, a large portion of it is disturbed and resulted in secondary types. The details of each type are discussed below:

Tropical forest

These forests are met within areas up to an elevation of 900 m and with an average rainfall of about 200 cm. They are more important from economic point of view and are the source of many of our useful plants yielding timber, fuel, fodder, medicine, aromatics and other non timber forest produce.

The major types of forest met under this group of forest are Tropical evergreen forest, Tropical semi-evergreen forest, and Moist deciduous forest.

Tropical evergreen forest

These forests usually occur in more wet slopes and valleys. These seldom form continuous belts due to various exogenous factors. They are complex in structure and rich in species diversity. They exhibit definite zonation and have impenetrable herbaceous undergrowth, particularly during rainy season. The tier-wise distribution of species is as follows.

Top canopy: *Sapium baccatum, Castanopsis indica, C. tribuloides, Dysoxylum spp., Xerospermum glabratum, Maniltoa polyandra, Elaeocarpus sp., Syzygium spp.*, etc. Some of the emergent tree species are deciduous and are represented by *Firmiana colorata (Sterculia colorata), Tetrameles nudiflora, Pterygota alata (Sterculia alata)* etc.

Second storey/subcanopy: This layer is almost obscure from the previous one and has tree like *Garcinia pedunculata, G. paniculata, Syzygium nervosum, Sarcosperma griffithii, Turpinia pomifera, Heritiera macrophylla, Ostodes paniculata, Knema linifolia, Chisocheton paniculatus* and many other species.

In many instances, a third storey would be discernible and the trees consist of *Oreocnide integrifolia, Alcornea tiliaefolia, Antidesma bunius, Ixora subsessilis, Prismatomeris tetrandra, Trevesia palmata, Saprosma ternatum* etc.

The ground flora of undershrubs and herbs includes *Dracaena elliptica, Leea edgeworthia, Phlogacanthus thyrsiflors, various Acanthaceous, Rubiaceous, Balsaminaceous,* and *Asteraceous spp.*, and according to the season these plants vary in their dominance.

Climbers and lianas form a characteristic species composition of these forests. To mention a few are *Bauhinia, Hodgsonia macrocarpa, Beaumontia grandiflora, Gnetum scandens, Ventilago calyculata, Cayratia, Entada phaseoloides, Schefflera venulosa, Chonemorpha fragrans, Ampelocissus, Bauhinia nervosa, Bauhinia khasiana, Combretum roxburghii,* etc. In addition, at some places one can see climbing bamboos vis. *Neomicrocalamus prainii* and species of Rattan (Cane).

The forest structure is incomplete without the mention of epiphytes. Many trees are perched with this group of plants belonging to Ferns, Orchids, Gesneriads, Piper, Aroids, Mosses and many others. The prevalence of stem clasping climbers are remarkable in the state.

Tropical semi-evergreen forest

This type of forest occupies the north and north eastern slopes of the state. Like the former, the forest is much complex and stratified. However, there is a preponderance of deciduous tree species along with evergreen species compared to the former type. *Tetrameles nudiflora, Dillenia pentagyna, Acrocarpus fraxinifolius, Terminalia sp, Careya arborea* are some such deciduous species. In this type of forest there is a lesser representation of epiphytes. The ground flora is also much seasonal with a greater representation of gregarious growth of Zingiberaceous species like Curcuma and ferns etc. This is also a treasure house of economically important species.

Tropical moist and dry deciduous forest

This is a very prominent vegetation of Meghalaya covering larger areas in, the East and West Garo Hills, Ri-Bhoi, etc. The rainfall in this forest belt is slightly lower than the previous vegetation areas. Temperature too is higher. These forest are characterized by seasonal leaf shedding and profuse flowering. They are much valued for their economically important species like *Shorea robusta, Terminalia myriocarpa, Bombax ceiba, Tetramalas nudiflora, Lagerstroemia parviflora, Gmelina arborea, Artocarpus chama (A.chaplasha), Morus laevigata* and *Vitex peduncularis*. Other important associated species seen are *Schima wallichii, Toona ciliata, Bridelia retusa, Albizia lebbeck, Terminalia sp., Albizia lucidior (A. lucida), Dillenia pentagyna* etc. Most of these trees are canopy forming.

The forest, as expected in a tropical region, has a complex tiered structure.

The middle storey trees seen just below the canopy are *Aporusa roxburghii, Croton roxburghii, Careya arborea, Rhus acuminata, Micromelum integerrimum, Bauhinia malabarica, Glochidion lanceolarium, Mallotus tetragonum, Meyna laxiflora, Grewia spp., Polyalthia sp.,* etc.

The shrubby layer is more gregarious and prominent. This stratum is represented by the species of *Phlogacanthus thyrsiflorus, Leea aspera, Desmodium, Flemingia, Holarrhena pubescens, Glycosmis pentaphylla, Allophyllus, Licuala peltata, Costus speciosus, Stachetarpheta urticifolia* and *Eupatorium* (mostly near open areas).

The common climbers and lianas seen here are *Bauhihia, Combretum roxburghii, Mussaenda frondosa, Hiptage benghalensis, Aspidopteris wallichii, Ventilago denticulata, Gouania leptostachya, Entada phasioloides, Spatholobus roxburghii, Chonemorpha fragrans, Toddalia asiatica, Cayratia* and others.

The epiphytic flora as expected is comparatively lesser here. However, those seen include *Dendrobium fimbriatum, Cymbidium aloifolium, Papilionathe vandarum, Rhynchostylis retusa* etc. from Orchidaceae, *Pseudodrynaria, Asplenium, Microsorum* etc. from ferns, Hoya from Asclepiadaceae etc.

Most of the deciduous forest fall under the sal forest which are infact man-made in nature. The composition of trees as well as the herbaceous flora vary much from place to place.

Subtropical pine forest

The pine forests are seen above the tropical zone and are confined to the higher reaches of the Shillong plateau in Khasi and Jaintia hills. The altitudinal range is from 900 -1500 m. The pine forests unlike the tropical forest are less complex in structure and comparatively poorer in respect of species richness when seen with tropical types. The canopy trees obviousely are of pines which tend to grow gregariously and in pure stands. The main species is *Pinus kesiya*. However, in certain places the pines are associated with a few broad-leaved species like *Acacia dealbata, Schima wallichii, Myrica esculenta, Erythrina arborescence, Rhus chinensis, Lyonia ovalifolia, Rhododendron arboreum, Quercus sp.* etc. Most of them are subcanopy species or middle storey species. There is, however not much stratification seen.

The shrubby layer is of *Rubus, Osbeckia, Spiraea, Neillia, Artemesia*, etc. The ground flora is seasonal and attractive flowering plants like *Chrysanthemum, Aster, Hypochaeris, Prunella, Plectranthus, Desmodium, Ranunculus, Anemone, Potentilla, Clinopodium, Polygonum* and *Elsholtzia* are common. They appear during summer/ rainy season. An exotic species, Eupatorium adenophorum and E.reparium are characteristic of this region. There is paucity of epiphytic and climbing flora, though they are scantily represented by orchids, ferns and Clematis.

The pine forests are a climatic sub-climax and are maintained at that level through recurring annual fires.

Subtropical broad leaved forest

In the same altitudinal zone with more wet areas, the very dense and complex structured broad leaved forest appear. Though, the tierwise dispersal of trees is not distinct, the canopy trees are *Lithocarpus fenestratus, Castanopsis kurzii, Magnolia, Schima wallichii, Rhus chinensis, Photinia arguta, Symplocos glomerata, Elaeocarpus prunifolius, Betula alnoides, Alnus nepalensis, Engelhardtia spicata, Castanopsis tribuloides, Quercus griffithii* etc.

This layer is followed by a number of smaller tree species like *Macropanax, Schefflera, Lyonia, Ardisia, Camellia, Eurya, Ligustrum, Wendlandia, Myrsine, Viburnum, Symplocos* etc. A very strong shrubby layer can be seen in these forests. The main species seen in this layer are *Neillia thyrsiflora, Spiraea, Osbeckia, Rubus, Diflugossa colorata, Viburnum, Maesa, Plectranthus spp., Symplocos spp., Clerodendrum spp., Solanum spp.,* etc. There are many species in this belt which are common with the temperate type.

The herbaceous ground flora is indeed different in different seasons. *Polygonum, Drymaria, Galinsoga, Ageratum, Osbeckia, Desmodium, Smythia, Prunella* and many others belonging to Asteraceae, Lamiaceae, Scrophulariaceae, Caryophyllaceae, Acanthaceae and Ranunculaceae are the usual representatives.

Temperate forest

The temperate forests in Meghalaya are confined to some high altitude pockets, particularly the sacred grooves. Though, these are not in the actual altitudinal zones of temperate forest, the species composition suggests their temperate nature, rather they could be termed sub temperate types.

These forest are seen above 1500 m. A special feature is the high rainfall associated with these areas. The trees seen in the canopy are *Lithocarpus fenestratus, Castanopsis kurzii, Quercus griffithii, Q. semiserrata, Schima khasiana, Solanea dasycarpa (Echinocarpus dasycarpus) Myrica esculenta, Elaeocarpus pruniifolius, Symplocos glomerata, Photinia arguta, Ficus nemoralis, Magnolia caveana, Acer sp., Exbucklandea populnea, Engelhardtia spicata, Betula alnoides, Rhododendron arboreum* etc. The canopy is quite thick and dense.

A well developed shrub layer can be seen in these forests. The dominant species include *Mahonia pycnophylla, Ardisia thomsonii, Viburnum foetidum, Daphne papyraceae, Polygala arillata, Camellia caudata, Neillia thyrsiflora, Ixora sp., Rubus spp.* Most of the herbaceous plants in this layer are seasonal and provide a spectacular change in the floral composition.

The epiphytic flora is exceptionally rich and comprise of Ferns, Lichens, Mosses, Orchids, Zingibers, Aroids, Gesneriads, etc. *Loxogramme involuta, Pyrossia spp., Pleione praecox, Coelogyne punctata, Agapetes obovata, Vaccinium donianum, Aeschenanthus sp., Hoya sp.*, are worth mentioning.

Climbers are less frequent but those seen include Kadsura heteroclita, *Hedera nepalensis, Codonopsis javanica, Holboelia latifolia and Clematis loureriana* etc.

Secondary forest

Due to various adverse factors, the climax forest gives way to secondary types. These factors could be shifting cultivation, urbanization, settlements, over exploitation, etc. Once the forest are removed, various successional stages of vegetation takes place and the secondary types like bamboo forest, grasslands or degraded forest result. The bamboo forest appears uniform and gregarious without much undergrowth. The main bamboo species are *Dendrocalamus hamiltonii and Melocanna baccifera* which are the most common ones. Some other species found less frequently are *Bambusa pseudopallida, Bambusa nutans, Drepanostachyum falcatum* etc. These are the preferred ones for cultivation. Bamboos also could be seen in forest gaps in the lower reaches and in degraded forest.

Grasslands: An interesting feature of the vegetation is the vast stretches of rolling grasslands. They are more prevalent at higher altitudes and are the results of removal of once occupied pristine forests, the relics of which could be seen amidst these grasslands as sacred grooves. The grasses belong to genera like *Panicum, Paspalum, Imperata, Axonopus, Neyraudia, Sporobolus, Saccharum, Chrysopogon, Oplisminus* and others along with sedges, dicotyledonous herbs like *Eriosaema, Polygonum, Trifolium, Smythia,* etc. In warmer areas, few scattered trees like *Glochidion, Callicarpa, Mallotus, Ficus* etc. amidst grasses make it a "savanna".

Degraded forest

This type of vegetation develops in jhum fallows which have long interval period between consecutive cultivation. Though the trees develop, but they are mostly pioneers and of inferior quality. There is poor species diversity compared to the original vegetation. Trees species include *Macranga, Mallotus, Glochidion, Bridelia, Grewia, Dillenia etc. along with the bamboo, Dendrocalamus hamiltonii and Melocanna baccifer*a.

Thus, it could be seen that though there is not much altitudinal variation as compared to the Himalayan states but there occurs a wide variety of vegetation types. This vegetation harbours one of the worlds' richest flora and biodiversity.

BAMBOO FORESTS OF MEGHALAYA

The extent of bamboo bearing area in the forests of the state is 5943 km^2 (ISFR (2017). However, in ISFR (2011), it was showm 4793 km^2. Thus change in the area with respect to ISFR (2011) is 1150 km^2. Density-wise details, number of culms by soundness and equivalent green weight are given in following tables:

Table-10: Bamboo bearing area by density in recorded forest area (Area in km^2)

Recorded Forest Area	Pure bamboo	Dense bamboo	Scattered bamboo	Clumps hacked	Bamboo regeneration	No bamboo
9,496	63	2,815	1,830	68	17	4,703

Table 11: Estimated number of bamboo culms and equivalent green weight

Number of culms (in millions)				Equivalent Green Weight (in 000' tones)		
Green	**Dry**	**Decayed**	**Total**	**Green**	**Dry**	**Total**
1109	104	38	1251	6334	1157	7491

Table-12 Distribution of bamboo bearing areas in Meghalaya (km^2).

Forest Divisions	Geographical Area	Bamboo bearing area	
		1986-88 (FSI)	**2002 – 04 (State Forest Resources Survey)**
Khasi Hills	10,443	1,729.52	1,250.83
Jaintia Hills	3,819	140.18	60.312
Garo Hills	8,167	1,233.02	153.55
Total	**22,429**	**3,102.72**	**1,464.68**

Source: FSI (1990) and State Forest Resource Survey (2002 – 2004)

According to the Forest Resources Survey of Meghalaya (2002-2004), the total area under bamboo in 1986 – 88 (pure bamboo area and overlapping/mixed bamboo area) was 3,102.72 km^2. It was highest in the Khasi Hills followed by Garo Hills and least in Jaintia Hills. The area under bamboo in 2004 – 04 was reported to be 1,464.68 km$^{2.}$ Pure bamboo brakes comprised of 664.72 km^{2,} whereas 2,438 km^2 was under bamboo mixed with forest trees (FSI, 1990).

Distribution of the different species of bamboo is not uniform in the state. Species like *Bambusa tulda*, *Bambusa bambos, Dendrocalamus hamiltonii* were mostly found in the Garo Hills, whereas *Melocanna baccifera, Drepanostachyum falcatum* and *Bambusa jaintiana* are more predominant in the Khasi Hills and Jaintia Hills. *Chimonocalamus*

griffithianus occurrs both in the Khasi, Jaintia and Garo Hills. Larger bamboo species such as *Bambusa balcooa*, *Bambusa bambos, Bambusa tulda, Dendrocalamus hamiltonii* and *Dendrocalamus sikkimensis* are distributed mainly in the lower elevations (< 500 m). *Dendrocalamus hookeri* and small diameter bamboo species such as *Phyllostachys mannii, Yushania hirsuta, Chimonobambusa callosa* are mostly found in the higher elevations (>800 m). Although there was a reduction in size of bamboo with the increase in elevations, it was observed that the districts of Meghalaya supported good growth and high yield of bamboo (Bhatt et al., 2004).

The bamboo forest were mainly confined to areas subjected to extensive jhumming (shifting cultivation) in the past. The State has 40 species 3 varieties and a forma (total 43) of bamboo belonging to 16 genera. Important genera of bamboo found in Meghalaya are *Bambusa, Cephalostachyum, Chimonobambusa, Chimonocalamus, Dendrocalamus, Drepanostachyum, Gigantochloa, Melocalamus, Melocanna, Neomicrocalamus, Phyllostachys, Pseudostachyum*, and *Teinostachyum*. Of these, *Yushania hirsuta, Cephalostachyum mannii, Bambusa jaintiana, Bambusa pseudopallida, Phyllostachys mannii, Melocanna clarkei* are endemic to Northeast India. The endemic species belong to the threatened category. *Genus Pseudosasa* and *Plioblastus* are exotic and under cultivation in Wardlake.

Table-13: Distribution of pure bamboo forests (km²).

Bamboo species Scientific name	**Districts**							**Total area**
	Local name	**EKH**	**WKH**	**JH**	**RB**	**EGH**	**WGH**	**SGH**	
Bambusa tulda	Rangai (K)	-	-	-	-	8.63	12.19	0.57	21.39
	Wago (G)				-				
Melocanna baccifera	Tyriaw (K)	-	-	0.68	0.42	-	-	-	1.1
***Bambusa pallida*	Skhen (K)	9.37	20.42	0.36	4.58	-	-	-	34.72
Chimonocalamus griffithianus	Sparheh (K)	5.84	-	0.76	-	-	-	-	6.60
Drepanostachyum falcatum	Tyra (K)	-	1.88	0.64	-	-	-	-	2.52

Dendro-calamus hamil-tonii	Siejbah (K)		-	-		22.04	14.14	10.91	47.09
	Wanok (G)								
Bambusa bambos	Wakynta (G)	-	-	-	-	-	-	14.5	14.5
Dendro-calamus hookerii	***Wadro (G)	-	-	-	-	-	5.2	-	5.2

Source: Forest Resources Survey, Meghalaya (2002-2004)

**= Correctly it should be *Bambusa jaintiana*

***= Wadro is the name in Garo hills for *Teinostachyum dullooa (Neohouzeaua dullooa)*

EKH = East Khasi Hills; WKH = West Khasi Hills; JH = Jaintia Hills; RB = Ri Bhoi; EGH = East Garo Hills; WGH = West Garo Hills; SGH = South Garo Hills; K = Khasi; G = Garo.

The number of culms of monopodial bamboo species was assessed at 350.34 million corresponding to an area of 472.54 km^2 with the total number of equivalent sound culm at 210.67 million (60.13%). In respect of the 2630.18 km^2 area bearing sympodial bamboos, 2,385.17 km^2 fell under non – hacked category and the total number of clumps in this area was assessed at 16.3 million with an average of 68 clumps per ha. The total number of equivalent sound culms was assessed at 260.39 million (62.46%). Over the entire region the total stock of bamboo was assessed at 471 million equivalent sound clums having a gross dry weight of 2,644 t (FSI, 1990).

BAMBOOS AND ITS USES

Bamboos are ranked as the special group from the beginning of human civilization. Origin of the word bamboo is still not clear. Some believe that it has been derived either from the Indian word "Mambu' or from Malayan word "Bambu". More than 1,500 applications of bamboos have been documented; of which major one include use as building material, agricultural implements, furniture, musical instrument, food items, handicraft, raw materials for large bamboo based industries like paper and pulp; and packing (Kishwan and Goyal, 2006). As regards to general consumption pattern of bamboos in India i.e. 35% bamboo is being consumed by pulp and paper industries, rest 65% is used for other purposes (Kulkarni and Rao, 2002). On world Environment day, 5th June 1999. The Prime Minister of India had announced the introduction of an integrated programme to promote and develop bamboo. The President of India on the Golden Jubilee of Handicraft resurgence in India on 15 Nov., 2002 also underlined the importance of bamboo.

American Bamboo Society Newsletter recently published a news item entitled "Bamboo in Indian future India investing $ 100 million for bamboo development" has emphasized the need of Agriculture and Environment Ministries to focus on bamboo development in order to create 5-6 million jobs in agriculture sector alone. Many state governments are keen to see the success in the Indian bamboo programme, because bamboo represents the potential for self-sufficient agricultural economics.

Uses: The strength of the culms, their straightness and lightness, combined with hardness, range in size, hollowness, long fibre and easy working qualities, make the bamboos suitable for a variety of purposes. Whether it is the tender shoots, used for pickles and curries, the slivers, used for tooth picks and meat barbecues, ribs for fans or slats for sun screens, or the dried culm as the sturdy lathi and for construction of the so called bamboo houses, the versatility of bamboo is legendary. The thousand and one uses for bamboos have long been known and established. Some of the traditional uses are: Agricultural implements, anchors, arrows, back scratchers, baskets, beds, blinds, boats, bottles, bows, bridges, brooms, brushes, buildings, caps, cart-yokes, caulking material, chairs, chicks, chopsticks, coffins, combs, containers, cooking utensils, cordages, dust-pans, fans, fences, fish-traps, fishing-nets, fishing rods, flag-poles, floats for timber, flutes, flower-pots, food, food-baskets, fuel, furniture, hats, handicrafts, haystack stabilizers, hedges, hookah-pipes, joss-sticks, kites, ladders, lamps, lance staves, lanterns, lining of hats and sandals, masts, match-sticks, mats, musical instruments, nails, net floats, ornaments, props, paper, pens, polo mallets, rafts, rayon pulp, roofing, sails, scaffoldings, scoops, seed-drills, shoes, shuttles, slats, sports goods, sprayers, stools, sticks, tables, thatching, tobacco pipes, toys, tool handles, traps, trays, tubes, umbrella-handles, walking-sticks, walls, vessels and wrappers. Some of the species have gained prominence in landscaping and few like yellow bamboo, black bamboo, pitcher bamboo, etc. are highly ornamental. For greening and beautifying the environment, bamboo is the low cost yet effective material. In Himalaya, Chinese bamboo i.e P*hyllostachys aurea, P. nigra, Psudosasa japonica* are used for the purpose in Himalayan states. Native bamboo, *Phyllostachys mannii*, is commonly planted as hedge in Shillong (Meghalaya), Mizoram and in Nagaland for beautification/ landscape. The leaves of *Bambusa vulgaris* are considered to be of high nutritive value; they are also fed to chicken as a deficiency diet to supplement vitamin A. Leaves and young culms of *Dendrocalamus strictus* are useful as coarse fodder, but should be cut before it flowers as the nutritive value decreases after flowering. Generally *Bambusa bambos, Cephalostachyum capitatum, Dendrocalamus hamiltonii, D. sikkimensis, Yushania maling, Ochlandra spp.*, are used for fodder; in Northwestern Himalaya the commonly used species is *Dendrocalamus somdevai, Drepanostachyum falcatum (Arundinaria falcata)* and *Thamnocalamus falconeri* and *Yushania anceps*. Goraya et al., (2008) stated that bamboos culms are lopped to browse for the cattle by migratory graziers. During their survey, it was mentioned that 34% of the total bamboo culms of *Sinarundinaria falcatum* and 21% of *Thamnocalamus spathiflorus* were lopped for fodder.

Apart from cattle, wildlife also depend on bamboos, Himalayan black bears and musk deer, feed on several species of genus *Arundinaria, Drepanostachyum* and *Thamnocalamus* in high altitude close to the tree line. In India, endangered red panda *(Ailurus fulgens)* is dependent on Himalayan bamboos. The red panda has been added to Appendix 1 of conservation on International Trade in Endangered species of Flora and Fauna (CITES). In China, over 99% of giant panda *(Ailuropoda melanoleuca)* feed on hill bamboos. Many birds like mountain bamboo-partrige, long-billed partrige, babblers prefer to take shelter and feed on bamboos (McNeely, 1996). Hill bamboos are the food plant of many butterfly species.

Bamboo charcoal is generally used by goldsmiths. In Japan, bamboo charcoal is used in gardening as it is believed to preserve to soil. The demand of activated carbon in India is increasing day by day.

Bamboo is considered generally a safe building material. Its capacity to survive an earthquake or a hurricane is well known. Thus in the construction of houses bamboo can play important role as a safe and economic building material. Many houses in the developing world are made entirely of bamboo, or use bamboo as a principle structure element. The concept of "growing one's own house" is common especially in Asia where families typically grow and maintain adequate bamboo stock to meet the need of maintaining house. Use in housing involved engineering applications, but the potential extends to other structures due to the excellent tensile strength properties of bamboo. The advantages of bamboos are:

- It is available plentiful in the Island.
- Can be obtained by the people themselves, but even if purchased, bamboo is far cheaper than other materials.
- During the earthquake and minor tremors, bamboo is much safer. If collapsing is it less dangerous than other structures.
- Bamboo can be carried by people on soulders.
- Bamboo hut is cool during the hot peak hours.

House Construction: Bamboo is employed in different ways as a building material for roof structure in form of purlins, rafters, reapers as reinforcement in foundations, flooring, doors/windows, walling, ceiling, water storage tanks, manhole covers and even for roads in slushy areas. Although urban Khasis of Meghalaya give more emphasis on the modern technologies and synthetic building material, yet bamboo houses are still common sight in rural Khasi and Jaintia Hills.

Roofing: Bamboo trusses form a good substitute for supporting roof loads and transmitting them to the foundations through columns. Bamboo trusses are fabricated using culms having an outer diameter of 50-80 mm. Seclected culms are placed in position and joining ends/faces are cut in such a way that the gap between two faces is

minimum. The web and chord connections are fabricated with different devices.

Bamboo reinforced mud wall: Mud wall gives protection against heat and cold. Now a days mud walls are constructed by reinforcing with quartered split bamboo culms properly treated with hot bitumen. Properly kneaded mud mixed with rice husk, cinder and a little lime and water are applied layer by layer keeping the bamboo grid in the center which is later plastered and smoothened then white washed.

Light bamboo wall: Common walls of rural housing. Bamboo boards are prepared by using flattened bamboo culms, which are then battened and nailed to form the wallets made with skins from the outside of the bamboo are used for the exterior wall after applying a coat of coal tar on outer surface for protection.

Flooring: Rural houses on raised platforms use bamboo for flooring while bamboo culms used as floor joints and beams act as framework. Over this framework, covering sheathings of split bamboo, bamboo boards/mats, small/full culms or flattened bamboo strips are suitably fastened.

Doors and windows: Shutters made of bamboo mats, fixed on wooden frame is common in rural housing. Small openings framed with bamboo or wood are provided in the walls to serve as windows.

Scaffolding: The platforms made of timber planks can be replaced with bamboo culms Bamboo poles lashed together have also been successfully used as scaffolding in high rise buildings.

ROLE OF BAMBOO IN WILDLIFE

With primary productivity as high as that of many forests, bamboo provides support to many species of wildlife. Some of these, such as elephants (*Elephas maximus)*, the wild cattle *(Bosgaurus and B. javanicus)* and various species of deer (Cervidae) and primates (including macaques *Macaca* and leaf monkeys *Presbytis)*, pigs (Suidae), rats and mice (Muridae), porcupines (Hystricidae), and squirrels (Sciuridae) are incidental feeders on Southeast Asian bamboos (Lekagul and McNeely 1977). Schaller et al. (1985) report that in China, sambar deer (*Cervus unicolo*r), serow (*Capricornis sumatraensis*), tufted deer (*Elaphodus cephalophu*s) and takin (*Budorcas taxicoor)* all feed on bamboo. In Borneo and Sumatra, even orangutans go into bamboo forests to eat the young culms. In the Himalayas, Himalayan black bears feed on several small species of bamboo in high-elevation forests close to the tree line. The impact of these species on bamboo can be considerable. Rodents gnaw rhizomes and the base of culms and seeds, while some species of squirrels eat the growing shoots. Pigs and porcupines also



dig up many young plants to eat the rhizomes and young shoots. Elephants can cause considerable damage as they move through bamboo forests, seeming to take pleasure in twisting 10-cm-thick bamboo into complex knots (Lekagul and McNeely 1977).

Perhaps more interesting are the species of wildlife that are especially, sometimes even totally, dependent of bamboo. The most famous of these is certainly the critically endangered giant panda (*Ailuropoda melanoleuca)*, whose distribution is determined by bamboo, though pandas prefer living in forests with a canopy coverage of 70% or more (Schaller et al. 1985). Over 99% of the food of giant pandas consists of bamboo, with an average adult eating about 4500 kg per year, amounting to an estimated 466000 shoots and stems, somewhat less than one percent of the available bamboo biomass per year (Schaller et al. 1985). In essence, pandas have specialized on a plant resource available in virtually unlimited amounts at all seasons, though the nutritional quality of bamboo is relatively low.

A closely related species which is equally dependent on bamboo is the red panda (*Ailurus fulgens*), found from Nepal to Sichuan. The red panda has recently been added to Appendix 1 of the Convention on International Trade in Endangered species of Flora and Fauna (CITES), indicating that it too is endangered.

Many species of bats feed around bamboo clumps in various parts of Asia. These are primarily insectivorous bats, such as kitti's hognosed bat (*Craseonycteris thonglongyai),* a number of a new family of bats discovered in Thailand in 1974. One genus of bats, Tyonyctiris, roosts inside the bamboo culm, susually *Gigantochloa scortechinii,* gaining entrance through narrow vertical slits originally made by a beetle. These bats have distinctive footpads and thumb pads enabling them to grip the interior of the bamboo (Lekagul and McNeely 1977). They also have a remarkably flattened skull, which enables them to enter the small slits in the bamboo.

Species of rodent apparently confined to bamboo habitats include the marmoset rat (*Hapalomys longicaudataus*) – which eats shoots, flowers and fruits of bamboo and lives in the internodes of the bamboo, which it enters though a round hole it has chewed in the internodes-and the pencils-tailed tree mouse (*Chiropodomys gliroides*) (Lekagul and McNeely 1977). One family of rodents, the bamboo rats (Rhizomydae) consisting of two genera and four species, ranging from China south of Yangtze to the eastern Himalayas and south to Sumatra, seem to be generally confined to the bamboo forests, feeding on bamboo roots and shoots, rhizomes, tubers, grass seeds and fallen fruits. They are burrowing animals, with some species weighing as much as four kilograms (Lekagul and McNeely 1977). Mathur and Chowmuhani (1991) have found a species of rat which they provisionally identified as 'Hoary rat'. The natural food of these rats in Tripura are bamboo rhizomes. When the rhizome are not available these rats look out for alternative food and rubber plant is their natural target. Kathal and Mango trees are also reported to be damaged by them in young stage in villages on the edges of bamboo forest.

With such high productivity, bamboo also supports many species of birds. In addition to the hundreds of species that may feed incidentally in bamboo forests, numerous species favour bamboo or are confined to this habitat MC Neely (1996) (Table 2).

Mountain bamboo-partridge	(*Bambusicola fytchii*)
Long-billed partridge	(*Rhizothera longirostris*)
Yellow-billed grosbeak	(*Coccothraustes migratorius*)
Tawny-breasted parrot finch	(*Erythrura hyperythra*)
Pin-tailed parrot finch	(*Erythrura prasina*)
Tickell's blue flycatcher	(*Cyornis tickelliae*)
Hill-blue flycatcher	(*Cyornis banyumas*)
Rufous-chested flycatcher	(*Ficedula dumetoria*)
Mountain tailor bird	(*Orthotomus culculatus*)
Yellow-bellied warbler	(*Abroscopus superciliaris*)
Rufous-faced warbler	(*Abroscopus albogularis*)
Golden-spectacled warbler	(*Seicercus burkii*)
Parrot bills	(*Paradoxornis*)
Fulvettas	(*Alcippe*)
Babblers	(*Stachyris*)
Silver-breasted broadbill	(*Serilophus lunatus*)
Maroon woodpecker	(*Blythipicus rubiginosus*)
Heart-spotted woodpecker	(*Hemicircus canente*)
Bamboo woodpecker	(*Geninulus grantia*)
Laced woodpecker	(*Picus bittatus*)
Speckled piculet	(*Picumnus innominatus*)
White-browed piculet	(*Sasia ochracea*)

It is clear, therefore, that many species of wildlife depend on bamboo, either partially or entirely. Conserving bamboo will help conserve these species as well.

BAMBOOS AND CLIMATE CHANGE

Bamboos fast growth, ability to grow on varied soils and climate, renewability and positive socio-economic impacts make them an excellent species for combating climate change. On one hand, high growth potential and ability to store large amounts of carbon make them a very good species for mitigation of climate change by way of carbon sequestration and on the other hand their environmental and socio-economic services can help communities in developing countries to adapt to the changing climate (Gera and Gera (2015). Research and growth modeling by the International Network of Bamboo and Rattan (INBAR) had shown that managed bamboos can be an effective carbon sink and perform better than Chinese fir and eucalyptus growing under similar conditions. Managing bamboos involves the annual, sustainable and selective harvesting of stem which are turned into products that can hold carbon for many years. The increasing popularity of durable bamboo products ensures that for the foreseeable future, productive bamboo systems can be considered as an important carbon sink (INBAR, 2009).

It is estimated that about 30 Bt of carbon dioxide equivalent is produced each year by human activity. Bamboos offer one of the quickest ways to remove vast amounts of that CO^2 from the atmosphere. Bamboos minimize CO^2 gas and generate upto 25 percent more oxygen than an equivalent stand of trees. One hectare of bamboo can sequester upto 62 t of CO^2 yr-1, whereas equivalent of young forest sequesters 15 t of CO^2 yr-1. The Guadua plantations in Costa Rica estimated to absorb 17 t of CO^2 ha-1 yr-1 (Janssen, 2000).



Another study by INBAR states that over the past 15 years, areas under bamboos in Asia grew by 10 percent. China, for example, plans to continue to plant more bamboos over the next many years. Studies have estimated that the carbon stored in Chinese bamboo forests will increase from 727.08 Tg C in 2010 to 1,017.54 Tg C in 2050, which equates to an increase of nearly 40 percent in 40 years. This represent a significant contribution to the Chinese forest carbon stock and a range that shows that policies aiming at combating climate change with bamboos can indeed have significant promise (Kuehl and Yiping, 2012).

Besides, bamboos in small holding systems also hold great potential in terms of livelihood generation as well as increasing the potential CO^2 sink. A study by Nath and Das (2011) in Barak Valley of Assam stated that the occurrence of bamboos in all homesteads coupled with progressive increase in culm density over the years reflects its potential for carbon storage. The study inferred that harvesting of mature culms was balanced by carbon gain from new culms produced in the culm. Carbon assimilation

ratio exhibited bamboo farming as an efficient carbon sequestration system other than pure plantations or natural forests. The study recommended promotion of small bamboos farming systems to reduce atmospheric greenhouse gas levels to receive certified emission reduction.

BAMBOO IN MODERN HEALTH-CARE APPLICATIONS



Since last few years bamboo is in the process of being rediscovered. Expanding green markets and interest towards herbal medicines offer opportunities for the development and promotion of bamboo-based health-care products (Tripathi, 2008). Through modern science and technological intervention, a number of new applications of bamboo have emerged in various commercial sector including health care. Some of the new generation products and their application in therapeutics and healthcare are described below.

Bamboo Wine and Beer: In Tanzania, a kind of wine is collected from the chopped off tips of *Oxytenanthera braunii* (Mgeni, 1983). Bamboo beer produced by fortifying bamboo leaf extract during the processing of normal beer, is characterized by typical aroma of bamboo leaves as well as a refreshing and mellow taste, abundant in bio-flavonoids and better activitie of anti-free radicals and anti-oxidation and excellent storage stability and lower re-ascend of siacetyl. Therefore, bamboo beer is a kind of high healthy beer, which can help lower blood-lipid when consumed frequently.

Bamboo Charcoal: Bamboo charcoals have more than 400 kinds of minerals and hundreds of medicinal benefits and effects for or health. Nowadays, the therapeutic apheresis has been adopted in various treatments of disease, such as hepatic and renal failure. The plasma perfusion is one the choices in therapeutic apheresis. Biocompatibility of bamboo charcoal for the apheresis application, morphology and pore size of bamboo charcoal obtained by carbonizing Taiwan bamboo and residual heay metals in bamboo charcoal have been investigated (Minf et al., 2007). In the biological assays, the cytoxicity of fibroblast cells and hemolytic effect to red blood cells of the carbonized charcoal were studied. The adsorption behavious of bamboo charcoal in the albumin or L-phenylalanine solution was also condi\cuted as a preliminary basis for future apheresis applications (Ming et al., 2007).

Bamboo Vinegar: The vapour that comes off the heated bamboo can be condensed to produce a liquid known as bamboo vinegar. It gets this name from the high content of acetic acid, though this ingredient is accompanied by many other compounds, especially phenols, such as guaiacol and cresol. This liquid can be applied in many purposed such as cosmetics, insecticide, deodorants, food processing, and agriculture. All these benefits were found since charcoal making started thousands of years ago in Japan.

Bamboo vinegar has been produced in Japan for many years and is used medicinally to treat eczema, atopic dermatitis, and other skin diseases; it is most commonly applied by adding to bath water. Bamboo vinegar is recognized as an anti-inflammatory and anti-fungal. It has re recently been popularazied as a main ingredient in 'sap sheets' applied to the feet to 'draw out toxins' (Yukin et al., 2004).

EDIBLE SHOOTS

A bamboo shoot is young culm of certain bamboo species that is harvested at the time it appears above the soil surface or shortly after for consumption. Various Indian bamboo species which produce edible shoots are listed in Table 14. This shoot is about 8-12 inches long and is encased in a thin, hard, protective sheath. When bamboo shoots start emerging from the ground; certain critical biochemical reactions are set in motion which leads to the rapid growth and hardening of the culm. These shoots must be harvested before they turn hard and woody and hence inedible. Shoots are generally produced by a mature bamboo culm every year during the rainy season. The yield varies from species to species and also the environmental conditions. *Bambusa polymorpha* is considered as one of the best in the world producing quality edible shoots, which have a distinct sweet taste in the raw state (Awasti and Tewari, 2008).



Chimonobambusa callosa



Dendrocalamus hamiltonii



Melocanna baccifera



Phyllostachys mannii



Khasi ladies selling shoots at Gauhati-Shillong Road



Garo ladies selling shoots at Tura Market



Dendrocalamus hamiltonii

Bamboo shoots have a high market demand in Meghalaya. A seasonal (May – August) sale of fresh bamboo shoots was reported form Meghalaya to the tune of 442 t (Bhatt et al., 2004). Among various districts. Khasi Hills exhibited highest sale followed by West Garo Hills District. Bamboo shoots are sold in the markets for a period of 40-70 days per year in all districts. In addition, bamboo shoot pickles and fermented slices are also sold in the markets throughout year. A total of 39.2 t of fermented shoots are sold in Meghalaya (Bhatt et al., 2005).

Table-14: Indian bamboo species producing edible bamboo shoots.

Name of species	Distribution/Consumed	Shoot size	Altitude
Bambusa balcooa	Bihar, North East, West Bengal, Uttar Pradesh, Bihar	Large	0-600 m
Bambusa bambos	Throughout	Large	0-100 m
Bambusa polymorpha	North Bengal	Large	0-800 m
Chimnobambusa callosa	Manipur	Small	900-1800 m
Dendrocalamus brandisii	Karnataka (Coorg)	Large	0-1300 m
Dendrocalamus giganteus	North East, North Bengal	Very Large	0-1200 m
Dendrocalamus hamiltonii	North East, North Bengal	Large	0-1200 m
Dendrocalamus hookeri	Arunachal Pradesh, North Bengal, Sikkim, Nagaland, Manipur, Meghalaya, Mizoram	Large	300-1800 m
Dendrocalamus latiflorus	Nagaland, Manipur	Very Large	1000-1500 m
Dendrocalamus longispathus	Mizoram	Medium	900-1500 m
Dendrocalamus strictus	Throughout except North East	Medium	0-1000 m
Melocanna baccifera	Throughout, Commonly in Mizoram	Medium	0-600 m
Phyllostachys mannii	Arunachal Pradesh, Meghalaya	Small	800-1500 m
Teinostachyum dullooa	Throughout	Medium	0-1200 m
Thyrostachys oliveri	Tripura, Manipur	Medium	0-650 m

YOUNG SHOOT AND THEIR CONSUMPTION IN MEGHALAYA

Species – wise sale of bamboo shoots showed that *Dendrocalamus hamiltonii* contributed to 82 percent of the total consumption, followed by *B. balcooa* (9.22%) and *M. baccifera* (8.76%), respectively. Often the distance traveled for bamboo shoot collection depends on the availability of the resources and distance of the market places from the bamboo forest. The average market rate of tender shoots of *Dendrocalamus hamiltonii* was highest (Rs. 5.16/kg), whereas shoots of *B.balcooa* were sold at lowest rate (Rs. 4.82/kg). The total gross income from fresh bamboo shoots was estimated to be Rs. 2.26 million per year, whereas annual net income of Rs. 1.14 million was recorded (after deduction of financial investment and wages for man days). A total of about 39.2 t fermented bamboo shoot products are sold in the market places of Meghalaya (Bhatt et al., 2005). A total of Rs. 1.18 million (gross income) could be generated from the fermented bamboo shoot products with a net annual income of Rs. 0.59 million (Bhatt et al., 2005). Pickles made of bamboo shoots sold in a single market place of Ri Bhoi District could fetch a gross income of Rs 0.4 million per yar with a net income of Rs 0.199 million per year.

To record the consumption of bamboo shoots in Meghalaya, 23 markets covering 113 vendors have been surveyed out of 50 nos. of total market places. Per day consumption of young shoots was highest (ca. 14.15 q/day) in East Khasi Hills followed by West Garo Hills (ca. 9.58 q/day). On an average, total consumption was ca. 4, 420.31 q/year with 61.4%, 32.11% and 6.50%, respectively, in Garo Hills, Khasi Hills and Jaintia Hills. Among various districts surveyed, East Khasi Hills exhibited highest bamboo consumption, followed by West Garo Hills and Ri – Bhoi district of Meghalaya.

Table 15. Availability/consumption of fresh bamboo shoots (± S.D.) in Meghalaya.

District	No. of markets	Markets surveyed	No. of vendors surveyed	Young shoots consumption market (kg day)	Young shoot consumption in all the markets surveyed (q/day)	Availability in the markets (days yr)	Total consumption (q/yr)
West Garo Hills	09	6	26	1.59±1.21	14.31	39.00±13.91	540.29
East Garo Hills	08	4	12	0.63±0.38	5.04	40.25±10.90	200.86

South Garo Hills	08	3	09	1.40±1.12	11.20	44.33±16.01	476.70
Ribhoi	07	3	18	1.40±0.28	9.80	53.00±08.48	509.50
East Khasi Hills	07	2	25	7.07±3.09	49.49	66.00±06.76	2,166.34
West Khasi Hills	06	2	12	0.76±0.32	4.56	71.00±15.56	313.76
Jaintia Hills	05	3	11	0.81±0.73	4.05	55.00±10.13	212.86
Total	**50**	**23**	**113**				**4,420.31**

Average consumption was 511.76, 3,381.18 and 525.55 q/yr respectively, for *Melocanna baccifera, Dendrocalamus hamiltonii and Bambusa balcooa.* The productivity of *Dendrocalamus hamiltonii* was recorded highest in East Khasi Hills district (1,867.78 q/yr) whereas *M. baccifera* and *B. balcooa* showed highest productivity in West Garo Hills and South Garo Hills, respectively. Among various species, *Dendrocalamus hamiltonii* alone contributed 76.52% of annual fresh shoot bamboo consumption in Meghalaya (Table 16).

Table 16. Species wise consumption (± S.D.) of edible bamboo shoots

Districts	**Total availability of bamboo shoots in each market (q/day)**			**Total consumption of bamboo shoots in all the markets (q/yr)**		
	M.baccifera	*D.hamitonii*	*B. balcooa*	*M. baccifera*	*D.hamiltoni*	*B. balcoona*
West Garo Hills	5.06	13.75	3.60	264.96	430.60	177.61
East Garo Hills	2.98	N.A	2.80	138.33	N.A	147.74
South Garo Hills	1.68	3.46	3.58	108.47	153.40	200.61
Ribhoi	N.A	8.42	N.A	N.A	446.26	N.A
East Khasi Hills	N.A	27.26	N.A	N.A	1,867.78	N.A

West Khasi Hills	N.A	4.04	N.A	N.A	215.84	N.A
Jaintia Hills	N.A	7.29	N.A	N.A	267.30	N.A
Total	**9.72**	**64.22**	**9.98**	**511.76**	**3,381.18**	**525.55**

N.A. – Not Available

Prevailing rate of the bamboo shoots varied from district to district and time to time viz. when the edible shoots remain available in plenty, the selling prices goes down, whereas, the prices goes up during the scarcity. However, the average rate of young shoot/kg was recorded as Rs. 4.95, 5.16 and 4.82, respectively, for *Melocanna baccifera, Dendrocalamus hamiltonii* and *Bambusa balcooa* (Table 17).

Table -17: Prevailing market rate (± S.D.) of edible bamboo shoots (Rs/kg) and wages for many days.

District	**Rate of young shoots (Rs/kg)**			**Wages for man-days (Rs/day)**
	B. balcooa	*D. hamiltonii*	*M. baccifera*	
West Garo Hills	5.39±0.75	4.23±0.72	5.04±0.98	55.00±5.00
East Garo Hills	4.66±0.62	N.A.	4.50±0.75	61.00±4.00
South Garo Hills	4.41±0.33	6.07±1.23	5.31±1.21	60.00±5.00
Ribhoi	N.A.	5.20±0.53	N.A.	70.00±5.00
East Khasi Hills	N.A.	6.04±1.21	N.A.	61.00±4.00
West Khasi Hills	N.A.	6.92±1.59	N.A.	65.00±5.00
Jaintia Hills	N.A.	7.66±2.04	N.A.	68.00±2.00
Total	**4.82±0.51**	**5.16±2.53**	**4.95±0.41**	**62.86±5.00**

N.A. Not Available

Cost – benefit analysis of edible bamboo shoots is presented in Table 18. Average gross output was recorded ca. 22,63,600.0 Rs/yr with a gross income of ca. 19,65,915.2 Rs/yr. The net monetary benefit (calculated including the wages for mandays engaged in harvesting to selling, transportation cost, purchase cost, if any, and various miscellaneous expenditures) was estimated to be ca. 11,38,554.0 Rs/yr.

Table :18 Cost – benefit analysis (± S.D.) of edible bamboo shoots, irrespective of species.

Districts	Gross output/ market (Rs/day)	Gross output of all the markets (Rs/day)	Gross output (Rs/yr)	Monetary inputs as the cost of bamboo shoot and transportation charges (for secondary seller) (Rs/yr)	Gross income after deduction of monetary inputs (Rs/yr)	Wages for man days required (Rs/yr)	Net income (Rs/yr)
West Garo Hills	85.68 ±10.52	4,084.00	2,04865.70	31,766.30	1,73,099.40	63,072.24	1,10,027 .16
East Garo Hills	93.32 ±15.03	3,666.00	1,19,949.59	24,760.40	95,189.19	49,878.00	45,311. 19
South Garo Hills	98.35 ±18.67	3,917.50	150,316.60	15,068.89	1,35,247.71	31,807.39	1,03,440 .32
Ribhoi	90.85 ±12.85	4,042.50	2,79,321.67	45,923.87	2,33,397.80	1,21,539.60	1,11,858 .20
East Khasi Hills	226.43 ±50.21	15,426.52	10,21,604.50	89,000.00	9,32,604.50	3,58,875.00	5,73,729 .50
West Khasi Hills	89.68 ±18.40	4,084.00	1,56,410.02	20,180.32	1,36,229.70	1,43,854.02	(-) 7,624 .32
Jaintia Hills	100.35 ±35.04	4,017.50	3,31,132.30	70,971.45	2,60,160.85	58,332.00	2,01,828 .85
Total	784.66	39,238.02	22,63,600.00	2,97,671.23	19,65,915.20	8,27,358.25	11,38,554 .30

Species wise cost – benefit analysis for young bamboo shoots is shown in Tables 19 – 21. Inter – comparing the cost – benefit analysis of various species, net monetary benefits was estimated highest through *Dendrocalamus hamiltonii* (ca. 8,16,069.0 Rs/yr – Table 20) followed by *Bambusa balcooa* (1,77,673.91 Rs/yr – Table 21), and *Melocanna baccifera* (Table 19), respectively. *Dendrocalamus hamiltonii* was found distributed almost in all the districts of Meghalaya except East Garo Hills whereas range of distribution of other two species was restricted to Garo Hills only.

Table 19: Cost – benefit analysis of edible bamboo shoots of *Melocanna baccifera.*

District	Gross output (Rs/yr)	Monetary input (Rs/yr)	Gross income (Rs/yr)	Wages for man days required (Rs/yr)	Net income (Rs/yr)
West Garo Hills	1,22,822.51	22,328.56	1,24,370.00	25,202.46	99,167.54
East Garo Hills	59,447.92	14,380.61	57,246.37	31,271.67	25,974.70
South Garo Hills	29,353.02	4,958.57	30,038.39	10,369.85	19,668.54
Total	2,53,321.20	41,666.86	2,11,654.34	66,843.98	1,44,810.36

Table 20: Cost – benefit analysis of edible bamboo shoots of *Dendrocalamus hamiltonii.*

District	Gross output (Rs/yr)	Monetary input (Rs/yr)	Gross income (Rs/yr)	Wages for man days required (Rs/yr)	Net income (Rs/yr)
West Garo Hills	59,107.06	20,015.30	39,091.76	40,327.72	(-) 1,235.96
South Garo Hills	24,438.94	16,012.92	8,426.02	7,943.05	482.97
Ribhoi	2,02,073.10	61,911.20	1,40,161.90	48,845.65	91,316.25
East Khasi Hills	6,95,136.62	1,36,746.58	5,58,390.04	1,23,750.00	4,34,640.04
West Khasi Hills	1,00,066.00	39,523.00	60,453.00	68,167.32	(-)7,624.32
Jaintia Hills	4,25,904.34	98,746.50	3,27,157.84	28,667.68	2,98,490.16
Total	**15,06,726.00**	**3,72,955.50**	**11,33,770.50**	**3,17,701.00**	**8,16,069.55**

Table 21: Cost – benefit analysis of edible bamboo shoots of *Bambusa balcooa.*

Districts	Gross output (Rs/yr)	Monetary input (Rs/yr)	Gross income (Rs/yr)	Wages for man days required (Rs/yr)	Net income (Rs/yr)
West Garo Hills	2,07,850.93	79,672.46	1,28,178.47	20,045.07	1,08,133.40

East Garo Hills	1,87,850.93	89,781.56	98,069.37	36,760.00	61,309.37
South Garo Hills	1,07,850.94	84,288.87	23,562.07	15,330.93	8,231.14
Total	5,03,552.80	2,53,742.89	2,49,809.91	72,136.00	1,77,673.91

Although bamboo shoots are harvested free of cost from the forests or home gardens however, its collection and selling needs extensive physical efforts. The distance travelled for bamboo shoot collection depends on the availability of the resources and distance of nearby market from the forest. Weight of the edible shoots varies from species to species with highest and lowest values to *Bambusa balcooa* and *Melocanna baccifera,* respectively. On an average, 5.65 to 15.0 kg of edible shoots are sold by each vendor in the nearby markets **(Table 22).**

Table 22: Physical efforts (± S.D.) made for collection and selling of young edible bamboo shoots.

Activities	**Districts**						
	West Garo Hills	East Garo Hills	South Garo Hills	Ribhoi	East Khasi Hills	West Khasi Hills	Jaintia Hills
Distance traveled from forest to -Village (km) -Market (km)	2.33±0.63 3.50±1.02	1.60±0.51 2,20.0.49	0.40.0.02 1.50±0.67	1.00±0.05 3.50±0.63	0.50±0.11 5.00±3.41	1.50+0.67 2.00±0.84	0.50±0.08 1.00±0.39
Average weight (kg/ shoot) *-M.baccifera -D.hamiltonii -B.balcooa*	0.36±0.08 0.82±0.11 3.09±0.98	0.29±0.02 N.A. 2.25±0.39	0.41±0.12 0.66±0.24 3.28±0.73	N.A. 0.73±0.12 N.A.	N.A. 0.33±0.03 N.A.	N.A. 0.45±0.31 N.A	N.A. 0.52±0.21 N.A.

Average weight of young shoot carried to market/day (kg/ seller)	6.94±3.04	0.08±1.93	7.62±1.33	10.42±2.41	5.65±4.81	9.51±3.10	15.02±4.22
Total time (hr.) consumed for harvesting, carrying, cleaning, selling etc. (per seller)	2.33±0.76	2.00±0.21	1.50±0.48	4.00±0.93	4.50±1.33	4.00±1.33	3.00±1.05
No. of vendors surveyed -Primary -Secondary	17 09	10 02	09 N.A.	17 1	13 12	08 04	11 N.A.

Labour contribution(%) -Male -Female -Child	30.00±5.00 60.00± 10.00 10.00 ±3.00	45.00±7.00 55.00 ±10.00 N.A.	40.00±5.00 50.00 ±10.00 10.00 ±3.00	25.00±7.00 70.00 ±10.00 5.00 ±1.00	10.00±2.00 75.00 ±10.00 15.00 ±3.00	20.00±2.00 70.00 ±10.00 10.00 ±1.50	50.00 ±5.00 50.00 ± 10.00 N.A.

N.A. = Not Available

Although, young shoots are mainly used for vegetable purposes, however, pickle is also made out of it. So far the survey was conducted only in one market and it has been recorded that about 26.0 q/year pickle is sold with a net income of Rs. 1, 13,029.0. Based on these estimates, small – scale industry of pickle processing can provide employment opportunity round the year to 9 persons only from one market explored (Table 23).

Table 23: Cost – benefit analyses of pickle in Ribhoi district.

Quantity of pickles/container (kg)	**Quantity sold (q/day)**	**No. of market days/yr**	**Total quantity sold (q/r)**	**Gross out put* Rs/yr)**	**Gross inpur* (Rs/yr)**	**Net income (Rs/yr)**
0.250	0.020	313	6.26	75,120.00	47,726.24	27,393.76
0.350	0.030	313	9.39	1,34,142.86	84,724.62	49,418.24
0.750	0.023	313	7.20	76,800.00	50.073.60	26,726.40
1.000	0.010	313	3.13	31,300.00	21,809.84	9,490.16
Average	0.021±0.01	-	6.496±2.60	79,341.00±		
42,172.09	51,084.00±					
25,826.10	28,257.00±					
16,361.33						
Total	0.083	-	25.98	3,17,363.00	2,04,334 .00	1,13,029 .00

* Gross output includes price of bamboo pickle in the market, which was 30.00, 50.00, 80.00 and 100.00, respectively, for 0.25 kg, 0.35 kg, 0.75 kg and 1.00 kg of pickle.

** Net income was calculated including the price of bamboo, shoots, wages of man days, required for pickle processing cost of ingedients (mustard oil, pickle powder, salt, chillies, spices, tartaric acid) and cost of container.

Mustard oil, pickle powder, salt, chillies, spices, tartaric acid are added @ 350 ml, 10.00g, 15.00g, 10.00g, 500g and 2.00g, respectively in one kg pickle.

Wages of man days for processing of 1 kg pickle = Rs. 15.50.

FERMENTED SHOOT CONSUMPTION

On an average, 860.45 q of fermented bamboo is being used in the state with annual gross output of ca. Rs. 25, 81, 350. Fermented shoots are sold for a period of 70 days in a year. Among various districts, Ri – Bhoi earned net monetary benefit of ca. 3, 67,080.0 Rs/yr followed by East Khasi Hills (ca. 1, 69,096.o Rs/yr), West Garo Hills (ca. 1,07,870.0 Rs/yr) and West Khasi Hills (ca. 1,00,671.0 Rs/yr). The net income through fermented shoots was calculated to be ca. 9,89,517.50 Rs/yr. Thus fermented shoots and fresh shoots equally contributed to the net income (Table 24).



Fermented shoots



Pickle

Table 24: Consumption of fermented shoots (± S.D.) with cost – benefit analysis*

Districts	Fermented shoot consumption (q/day)	Total consumption (q/yr)	Gross output (Rs/yr)	Monitory input (Rs/yr)	Gross income	Mandays required	Net income (Rs/yr)
West Garo Hills	1.34±0.45	93.80±3.45	2,81,400.00	93,800.00	1,87600.00	79,730.00	1,07,870.00
East Garo Hills	1.12±0.33	78.40±9.12	2,35,200.00	78,400.00	1,56,800.00	66,640.00	90,160.00

South Garo Hills	0.98±0.12	68.60±8.80	2,05,800.00	68,600.00	1,37,200.00	58,310.00	78,890.00
Ribhoi	4.56±0.56	319.20±7.80	9,57,600.00	3,19,200.00	6,38,400.00	2,71,320.00	3,67,080.00
East Khasi Hills	2.10±0.12	147.04±2.34	4,41,120.00	1,47,040.00	2,94,080.00	1,24,984.00	1,69,096.00
West Khasi Hills	1.25±0.45	87.54±3.14	2,62,620.00	87,540.00	1,75,080.00	74,409.00	1,00,671.00
Jaintia Hills	0.94±0.34	65.87±2.13	1,97,610. 00	65,870. 00	1,31,740. 00	55,989. 50	75,750. 50
Total	12.29	860.45	25,81,350. 00	8,60,450. 00	17,20,900. 00	7,31,382. 50	9,89,517. 50

***Market days as 70.0±4.5 for the state**

Distribution of the various edible bamboo species in Meghalaya has been shown in Table 25. *Bambusa balcooa* and *Melocanna baccifera* are mainly confined to Garo Hills, whereas, *Dendrocalamus hamiltonii, Dendrocalamus hookeri* are the main species of Khasi and Jaintia Hills, besides its occurrence in South and West Garo Hills of Meghalaya. All the species mentioned above are frequently cultivated in home gardens besides their occurrence in forest.

Table 25: Major edible bamboo species of Meghalaya

Bamboo species	Local name/dialect	Districts
Bambusa balcooa	Barwa (Garo)	East Garo Hills, West Garo Hills, South Garo Hills
Dendrocalamus hamiltonii	Wanock (Garo); Sitchlow (Khasi – Ri – Bhoi District); Lungsiej (East and West Khasi Hills); Plung (Jaintia)	East Khasi Hills, West Khasi Hills, Ri – Bhoi, Jaintia Hills, South Garo Hills, West Garo Hills
D.hookerii	Denga (Khasi); Sieijong (Jaintia)	East Khasi Hills, West Khasi Hills, Jaintia Hills
Melocanna baccifera	Wathri/Gaja (Garo)	East Garo Hills, West Garo Hills, South Garo Hills.

The average length of fresh shoots was recorded highest (28.65 cm) in *Dendrocalamus hamiltonii* and lowest in *Melocanna baccifera* (24.55 cm). Basal diameter (13.12cm) and shoot weight (2.87 kg/shoot) was noticed highest in *Bambusa balcooa* (Table 26).

Table 26: Size, shape and weight of edible bamboos of Meghalaya.

Bamboo species	**Bamboo shoots**			
	Length (cm)	Basal diameter (cm)	Shape	Weight (kg/ shoot)*
Bambusa balcooa	27.57±2.15	13.12±2.35	Conical short and stout	2.870±0.703
Dendrocalamus hamiltonii	28.65±2.45	8.17±1.89	Conical	0.585±0.072
Melocanna baccifera	24.55±5.32	4.15±0.12	Cylindrical	0.353±0.072

***Weight with culm seath/cleaned shoots.**

BAMBOO CRAFT OF MEGHALAYA

Bamboo is significant in the economic life of the Khasi, Garo & Jaintia Bamboo forms an important part of their domestic use and also forms an important medium of income generation. Selling of bamboo made products is facilitated through the market economy. It is an excellent resource for employment-generating. opportunities. With its multiple uses and high value in a range of products aimed at national and international markets, there are many entry points for which it can be and appropriate for resource-poor people. Bamboo is a fundamental part of their overall livelihood. In some cases, it may be mainly for home consumption, as a raw material used to make household utensils, farm tools, as a building material for making shelters, fences, bridges etc. Abundance of bamboo in the forest it possible for the Khasi people to make goods out of it for domestic as well as commercial purposes.

Cane and bamboo craft is almost regular manufacturing activity of the Khasi, the Jaintia and the War tribes. Almost every man of these tribes is expert in bamboo and cane work. The trade of handicrafts from Meghalaya to different places is through the middlemen and agents. These two avenues of marketing constitute about 62.04 and 23.41 percent respectively. The handicrafts are also sold directly in the markets and these constitute around 11.39 per cent while it is only 3.61 percent through the Government agencies. They manufacture varieties of baskets and other bamboo products. The smallest baskets are the measuring baskets. It is still popular in rural areas but in urban areas the concept of measuring with traditional baskets have changed totally, where standard modern methods are in vogue. However the larger baskets like storing baskets and carrying baskets are popular in urban areas even today. These baskets are of various types. They are single weave type, double weave type, hexagonal pattern, simple patterns and so on. Depending on the end use, the basket may have lid or may not. Due to influence of modernization and exposure, the artisans residing close to Shillong have also started manufacturing quality cane and bamboo furniture. However, basket work dominates in variety over other range of cane and bamboo products. Bamboo handicrafts are mostly produced in rural areas of Meghalaya. These handicraft items are an important part of tourist attraction, and are also exported to other parts of the country and abroad as well. Meghalaya Khadi and Gram Silpa sell such handicraft items to the tune of Rs. 50,000/ year.

In Garo hills, the spinning implements and the loom is made of bamboo and wood. They use traditional throw shuttle loom. The stand and the reed of the loom is always made of bamboo. The shuttle is sometimes made of wood and sometimes of bamboo. Most Garo craftsmen usually produce traditional clothes to meet the demand of their villagers and also dispose off their products in the villages itself either in cash or kind.

The men folk of the Garo tribe are expert in bamboo work and basketry. They manufacture several types of baskets according to their need in day – to day life. Artistic baskets known as Meghum khoks are made in the Garo hills and are used by tribes to store valuable items including cloths (Tiwari et al. 2008). The smallest baskets are the measuring baskets they use for measuring paddy, pulses and other grains. The also make bamboo screens for filtering alcohol, water and other liquids. The carrying baskets are usually conical with straps to tie behind the back. They carry goods up the hills easily with the help of these baskets. For storage of liquids like alcohol they plaster it with sap of fig tree, which gives waterproof rubber like layer. Storage baskets are of various sizes and shapes depending on the products need to be stored. Large storage baskets are made with stands below, narrow mouth and bulging center with plaster of cow dung all over to store paddy and or rice. Cow dung plaster is believed to protect the crop form insect attack. It is normally single weave type. It also has a lid. For keeping valuables and clothing a sort of double weave basket with lid is used sometimes wit hexagonal weave. It is not only useful but also beautiful to look at. There are also baskets to keep yarn, to keep vegetable and so on and each on of them is beautiful and useful.

The tradition of bamboo craft and basketry is very rich in Koch tribe. While dancing they use a type of belt made of bamboo splits to keep their petticoats in place. Baskets they make are of various types. Bigger baskets are usually kept at a corner not for moving from one place to another. In such baskets food grains are stored for longer period. There are smaller storage baskets, which can be moved form one place to another when need, arises and also can be made stationery if necessary. Type of weave and design in both the cases are identical provided that the type of materials to be stored are identical.

The carrying baskets are usually conical and having lid and straps attached. It is therefore easy to carry down and up the hills. There are also small baskets usually attached to the belt around the belly meant for keeping tobacco, betel leaves, betel nuts etc. It is important to note that mats are often purchased by outside traders from the Garo cane and bamboo workers.

The Atong tribe is believed to be cross between the Garo and the Koch tribal groups. Their traditions of basketry is also identical to these two groups.

BAMBOO AS RAW MATERIAL FOR PULPING

Although there is no paper mill in the State, a huge quantity of bamboo from the Khasi, Jaintia and Garo Hills finds its way to the paper mills in the neighboring State of Assam. Unpublished literature reveals that there is an annual demand of 50,000 t of bamboo from the State as raw material to Nagaon Paper Mill, Jagiroad. The largest quantity of bamboo supplied to this paper mill is met by *Dendrocalamus hamiltonii* from Ri Bhoi District and *Melocanna baccifera* from Garo Hills District.



Bamboo for paper pulping

In another paper mill, the Cachar Paper Mill located at Hailakandi District of Southern Assam, the demand and supply of bamboo from Meghalaya was estimated to be 20,000 t till the year 2004. This demand was actually being met from the bamboo forests of Jaintia Hills. This suggests that there is a potential of supplying atleast 20,000 t of bamboo from Jaintia Hills of Meghalaya.

The supply of bamboo from the State is generally made through local contractors/mahaldars. They purchase bamboo from the State Forest Department and Autonomous District Council based on certain terms and conditions for a limited period of time. Bamboo is also extracted from the private and community forests, and purchased directly form the owners and local contractors. Extraction of bamboo by the contractor is carried out through the inhabitants/laborers of the locality. They are either paid as man days or per truck loads depending on the convenience of the contractor. A truckload can accommodate approximately six tones of fresh bamboos. Contractors sell this bamboo to the paper hills at the rate of Rs. 1000/t or Rs 6000/ truckload. Hence, there is a total outturn of Rs. 50 million from bamboo sector by exporting about 50,000 t of bamboo to paper mills

These range from furniture, baskets –mats, bows and arrows and other artistic and carved items, which have over the years adorned every modest home of the Khasi, Jaintia and Garo tribes of the State. The rural artisans in the State are generally not aware

of the market potential of their products. They do not known the tastes and preferences of the ultimate buyer/user outside the State. There would be four of five intermediaries before the product actually reaches the end user. Our recent survey revealed that most of the handicraft artisans are facing the problem of marketing their finished products at reasonable prices. Some Garo cane and bamboo workers nowadays bring mats, baskets and winnowing fans to be sold in the weekly markets.

MARKET AND ECONOMICS

Quantity of extraction from the forests of Meghalaya varies from year to year. Records from the State Forest Department as well as the respective District Councils show low extraction of bamboo in the State. This does not take into account the local consumption and those which go through the informal route of trade. However, data collected from the paper mills above suggest that more than 50,000 t of bamboos are sold to them every year. Data on production of commercial bamboo in the Jaintia Hills are not available. Highest production was seen in the Khasi Hills with an average of 23,045.85 t annually. In the Garo Hills, official figure records a very low production of bamboo for commercial purpose. The highest production of bamboo (64,835.01 t) in the State was recorded in the year 1995 – 96 (Table 27).

Table. 27: Annual sale of bamboo from forests of Meghalaya. (Tones)

Year	SFD	KHADC	GHADC	Total
1995-96	NA	28168.34	36666.67	64835.01
1996-97	NA	27327.66	30000	57327.66
1997-98	NA	15244.11	18566.67	33810.78
1998-99	NA	16759.57	10066.67	26826.24
1999-00	27.66	14314.91	14266.67	28609.24
2000-01	NA	9787.66	10066.67	19854.33
2001-02	974.04	37433.83	9000	47407.87
2002-03	12625.6	15744.34	5250	33610.94
2003-04	NA	29239.53	9666.67	38906.2
2004-05	NA	36438.64	11666.67	48105.31
Total	13627.3	230458.59	155216.96	399302.6

SFD = State Forest Department, KHADC = Khasi Hills Autonomous District Council, GHADC= Garo Hills Autonomous District Council, Source: State Forest Department, Shillong; KHADC, Shillong and GHADC, Tura.

As reported, there is a total outturn of Rs. 50 million only from the bamboo sector by selling bamboo in raw form. The remaining quantity of bamboo produced is used in the State itself for meeting the needs of the local people mainly for food, construction purposes, handicrafts and also for the manufacture of plywood. A market

survey has revealed that the price of bamboo varies from district to district. In Garo Hills, the market rate of bamboo is Rs. 225/t' in Jaintia Hills the rate of bamboo is Rs 1500/t and in Khasi Hills the rate is Rs. 2100/t.

Note: GHADC and State Forest Department have the same rates of royalty.

Source: Working Scheme for Selected Private/Community Owned Forests in Khasi Hills, Shillong: State Forest Department, Forest Resources Survey, Shillong.

CONTRIBUTION OF BAMBOO TO STATE EXCHEQUER

In Meghalaya, royalty is levied on the forest produce, which comes from the forests falling under the management and control of the Khasi Hills Autonomous District Council (KHADC). However, even forest produce extracted from private forests are subjected to pay royalty collected by the KHADC. Such forest produce are subjected to the Khasi Hills Autonomous District (Management and Control of Forest Revised Rates of Royalty) Rules, 2005, which became effective from April, 2005. The revised rates of royalty levied on bamboo as per Schedule of Rates of Royalty varies from species to species. The royalty collected by the KHADC and GHADC differ from species to species as shown in Table 28. In Khasi Hills, the royalty rate for **Bambusa pallida* and *Dendrocalamus hamiltonii* are Rs. 60/100 numbers and for *Bambusa vulgaris* and *Bambusa balcooa* Rs. 100/100 numbers. For *Bambusa tulda* the rate is Rs. 48/100 numbers, for *Melocanna baccifera* Rs. 24/100 numbers and for *Teinostachyum dullooa* Rs. 20/100 numbers. In Garo Hills also the rates of royalty for bamboo differ from one species to another. For *Bambusa tulda* and B*ambusa balcooa* the rate is fixed to Rs. 125 and for *Melocanna baccifera* and **Bambusa pallida* rate of royalty is Rs. 100/100 (Source: GHADC, Tura). In Jaintia Hills, the royalty of bamboo is Rs. 60/100 numbers. (Source: JHADC, Jowai). For other bamboos species of 5 cm and above in diameter, the rates of royalty as per the KHADC and GHADC are Rs. 20 and Rs. 68, respectively. For bamboo species which are of 2.5 – 5 cm diameter, the royalty in Garo and Khasi Hills is * It should be *Bambusa jaintiana* because *B.pallida* has no distribution in Meghalaya Rs. 10 and Rs. 40, respectively. For bamboo which are less than 2.5 cm diameter, the royalty rate in Khasi Hills and Garo Hills is Rs. 80 Rs. 15, respectively. State government collects royalty on the bamboos extracted from the forests falling under their control. The State government royalty rates are: B. tulda Rs. 150/100 numbers, *D.hamiltonii* Rs. 150/100 numbers and for other species above 5 cm diameter, the rate is Rs. 66/100 numbers. (Tiwari et al. 2008)

Table 28: Rate of royalty (Rs.) for 100 numbers collected by the KHADC and GHADC.

Bamboos	**Khasi Hills**	**Garo Hills**
Dendrocalamus hamiltonii	60.00	125.00
Bambusa tulda	48.00	250.00
Bambusa pallida/jaintiana	60.00	100.00
Bambusa vulgaris	100.00	
Bambusa balcooa	100.00	250.00
Melocanna baccifera	24.00	100.00
Teinostachyum dullooa	20.00	68.00
Other bamboos > 5 cm dia	20.00	40.00
Other bamboos < 2.5 – 5 cm in dia	10.00	15.00
Other bamboo less than 2.5 cm in dia	8.00	

MANAGEMENT OF BAMBOO IN TANGMANG VILLAGE

According to Tiwari et al., (2008) people of Tangmang village, in the Southern part of Meghalaya, under the Pynursla Community Development Block follow a traditional system of bamboo management. In these areas, before planting bamboo, the area is cleared by burning the undergrowth. Burning of forest is carried out once in a year between March and April in the area where bamboo plantation is to be taken up. Most of the bamboos found in the village are planted, although they also grow in wild. The most important bamboo species used in the village are: *Bambusa jaintiana* (Shken) and *Bambusa sp.* (Rngai).

PRODUCTION OF PLANTING STOCK, PLANTING AND AFTERCARE

There are two methods of propagation. The most common method is through rhizomes with culmstock and roots. If the culm is young, it is maintained intact and if it is large, the upper part is removed and branches are trimmed. After cutting, the rhizome is transported and transplanted 30 cm apart in 20 – 30 cm deep soil.

Another method of propagation is by rooting of culm cuttings. Segments of one or two nodes are selected from the lower to basal part of one – year – old culms. The upper part and the lateral branches of the culm are discarded. Immediately after cutting, the segments are transported and transplanted. The culm segments is planted in 20-30 cm apart 20 – 30 cm deep soil and leaving the upper segment (about 10-15 cm) without soil cover. The propagules are transplanted in the month of April. After one year, the transplanted rhizomes start growing. However, growth through culm cuttings takes a longer period and has smaller diameter culms than that of rhizomes in the first year of growth. Within 5-6 months after emergence, the culm attains its full height. These culms are then allowed to grow and multiply for 5 years. Thinning is done once a year during rainy season (May – August). Both male and female labourers are engaged in cleaning and weeding. The branches of dense bamboo clumps are trimmed and dead culms and branches are removed to give space for new culms to grow. (Tiwari et al. 2008).

HARVESTING

Extraction of bamboos from village forest is not allowed. However, dead culms and branches can be collected for fuel wood. Harvesting of bamboos is carried out during winter (December – February). Males are usually involved in harvesting and carrying of bamboo poles from forest to their residences. Bamboo is harvested for different purposes such as local house construction, fencing, flooring, animal cages, for making mats, baskets, trays, caskets and other household items. A large knife or wait is used to cut bamboo poles form clumps. The poles are cut at a point about 0.6 m above the ground. Straight, well formed poles are preferred, with an average age of 3 years. However, for mat making, 1 – year-old bamboo is most commonly harvested. The number of poles harvested per person depends upon the distance from the assemble point, the size of bamboo poles cut and the means of transport available to the collection team, among other factors. In general, bamboo is transported from the forest to collection sites on foot by collection teams usually comprising of 3 to 5 members.

The sprouting period of bamboo is during May – July. Harvest of bamboo shoots is done during summer season (May – July). Only young shoots of *Bambusa sp*. (Rngai) is preferred for edible purposes. The villagers do not harvest young shoots of *Bambusa jaintiana* (Shken) for edible purpose. *Bambusa jaintiana* is one of the most important bamboo species of forest. It is also cultivated by the villagers mainly for construction purposes, mat weaving, baskets, caskets and other items. (Tiwari et al. 2008).

Harvesting and storage of dead bamboos

In the last gregarious flowering of *Melocanna baccifera* there was 26 million tones of bamboo was available due to large scale of death after flowering clumps, of which is only 10 million tons are is accessible areas of Northeast India (Goala and Borthakur, 2002). Efforts should be made to harvest a substantial amount of such huge quantities of death bamboos from inaccessinle areas. State government of Tripura, Mizoram, Meghalaya (from Garo hills), Manipur may take a policy to allow extraxt of bamboo from flowered areas (Banik, 2010).

MAT/BASKET WEAVING/TRAPS

It is important to note that mats are often purchased by the outside traders from Garo cane and bamboo workers. *Bambusa jaintiana* is mainly used for weaving mats. Mat making is one of the main occupations in the village. During the household survey, it was found that it contributes to Rs. 0.1 million to the annual income of the villagers which is around 5.77 per cent of their total income from all sources. The processing work in mainly done by the female members of the family, and 90 percent of the surveyed households were involved in mat – making. It was observed that the mat – making was seasonal and prevalent only during the rainy season (May – September) and during periods when there was shortage of work in the field. Thus it can be said that this activity helps them to get employment during the lean seasons to sustain their family.

The Khasis make different types of bamboo basket (Khoh) which are used either as 'carrier' or as 'container'. The baskets, used for different purposes, are of different sizes and of varying shapes. But they all conform to conical shape. The conical shape prevents water from a accumulation and also allows any fallen water to trickle down slowly and gradually. Khoh wanly with wide interstices is usually used for carrying scroll of betel leaves. A special kind of basket Khop trop woven out of bamboo has a cover to protect the contents from rain. This has a special utility in the long journey. Oranges are also carried in these baskets. Khoh-kwai, the large cylindrical bamboo baskets are used for keeping areca nuts in the curing ponds. Khoh kit briew, a conical structure with a seat provided is used for carrying sick presons or traveler. Artistic baskets known as Meghum khoks are made in Garo Hills, and are used to store valuable items including cloths. Following other material prepared by the villagers.

Tying chunks of meat: Villagers domesticate some animals like pigs and poultry. These are essentially reared for meat and egg. The pigs are reared in the open. Pigs are killed by the villagers for pork. After the meat is chopped into some chunks, it is pierced with a sharp bamboo strip and tied so that it becomes easier to carry and sell around in the same villages or other villages.

Hunting and fishing: Villagers make use of bamboo for making various traps in the agricultural fields. In order to protect the crops from being eaten by animals, the villagers make such traps by using mostly bamboo material along with other materials like wood, stone etc. Besides trapping animals to protect the crops, they also eat their meat. Some rodents are especially trapped in the field in winter as the people relish the meat. The villagers also depend on fish from the stream for their diet. In order to catch the fish, the people make fish traps. Some even trap birds also for their meat. The people by using bamboo strips are able to carry the caught fish by piercing them from the gill to the mouth. In this manner, excess fish caught are sold to other villages which are away from the stream.



A young Garo boy hunting birds with bamboo stick



Fish trap

Ruh khnam (fish trap): Fish trap is made out of bamboo mainly designed to be used in the running water while trapping fish. It is a trap that does need manipulation by hand. It has valves which is a trap door through which fishes can get into the trap easily but cannot come out. This trap is either single or double valves.

Tynsong (fishing net): It is a hand operated net which is conical in shape. The round edge generally has a bamboo frame which is tied to a long bamboo shaft for easy manipulation. The main body of the net is made of synthetic fibre. This net is useful for catching small fishes from rivers and streams.

Bniej/kriah tong doh (fishing tra): This is another kind of fish trap used for trapping small varieties of fish from the shallow river bed. It is woven in the fine twilled pattern. The shape of this trap is somewhat like a winnowing tray where the front end is flat and wide opened but the rear end of this trap tapers and folds itself into an elongated cone which serves as a handle. This trap is finely woven by using bamboo D*endrocalamus hamiltonii* (Siejlieh) and *Bambusa jaintiana* (Shken).

Ryngwiang khwai (fishing rod): A fishing rod is a simple bamboo pole of approximately 200cm long. One end of this rod is tied with a fishing thread bought from the market. Along with this thread, a metal hook with a worm which acts as a bait is attached to the free end of the thread. When this hok is lowered in the water, the fish is attracted towards the bait.

Kriah thep doh (fish container): This is a basket meant for keeping the bigger varieties of fish when caught. It is not woven like other container or baskets but rather it is a simple container made with long sticks of bamboo. It is oblong in shape and is provided with a belt so that it can be carried on the shoulder whenever needed.

Ruh wait (bamboo bag for carrying dao): This bag woven out of bamboo strips, apart from being used for carrying dao and other tools to the field, is also used for carrying home the shersyngkai, a small variety of fish caught from the river.

Ryngshop (fish trap): This is another fish trap made with bamboo in the form of a cone, the base of which is tied to a bamboo pole. After barricading the water in the stream, the ryngshop is kept in the middle of the flowing stream so that fishes will be caught inside this trap.

Riam siat (arrow-like trap/shooting trap) : This trap was used in the past for trapping bears, tigers and deer. The villagers made use of an ingenious species of arrow-like trap or spring gun for killing game, the spring gun being laid alongside a bear, tiger or deer path in the jungle. A string stretched across the path, when touched, releases a bolt and spring, which later impels a bamboo arrow with great force across the path. This spring gun is called ka riam siat. An arrow is tied with a strong thread towards a fixed pole and as soon as a game happened to pass near this place, the arrow would swiftly fly like a fillip directly at the animal. This shows that once the area was a sanctuary of various

types of wild animals. But as so much of jhum cultivation was practiced in the past coupled with merciless killing of animals most of those fauna have now become extinct.

For trapping small animals on the ground : Mawmyntem (stone trap): It is a trap for small animals that run about on the ground. A large stone and a stick or bamboo is used for creating this trap. One end of the chunk of stone touches the ground while the other end is lifted up by keeping either a stick or bamboo vertically on the ground with one end of it under the chunk of stone. When the game wanders about in search of food a slight touch with the bait being tied under the stone is enough to waver it. As a result the stone falls right on top of the animal.

Iing shrieh (monkey house): This is a type of cage trap used in the tapioca fields. Ïingshrieh is made by fencing the trap house with Melocanna clarkei as this small variety will simply suffice when used with some sticks. It is a trap house in which the animal enters in search of food. A door is kept opened on top of this house by tying with a rope towards a small hut nearby. Bait is always kept inside this house as they feed the monkeys continuously for a week or so before trapping them.

On the day they decide to trap the monkeys, a main hiding inside the nearby hut will cut the rope that is tied the the door of the trap house while the monkeys inside are leisurely feeding on the habit. Thus the door of the trap will be closed and the monkeys are trapped.

Lang-ar (pit fall trap): A deep pit is dug out on the regular path of the animals and kept covered with leaves. Unscrupulous animals fall into this pit while passing, but they cannot escape. Sharp spikes of bamboos are placed vertically into the pit which injures the animal badly. Monkeys who often create nuisance in the maize fields are often hunted by using such trap.

Tang panai (monkey trap): This is another variety of monkey trap whereby a rope is tied from a tree to one end of a bamboo pole, while another end of this pole is fixed on the ground. Some banana are tied to this rope so that when the monkey comes from the tree and reaches for the bait, with the slightest mistake in balancing it will fall down from the rope either dead or injured as the bamboo spikes are placed vertically on the ground below the rope. The people find it rather amusing to see the game being trapped as the animals always bother the crops grown by the villagers.

Mynsham (bird trap): This is used for trapping birds in the agricultural fields. For making this type of trap a long stick along with bait is kept horizontally on two vertical sticks which act as a support. One end of a long bamboo is fitted to the ground while the other end is locked onto the horizontal stick. As soon as a bird sets its foot onto the horizontal stick lured by the bait, the bamboo attached to this horizontal wood piece dislodges the trigger and the noose gets tight. Thus a bird gets trapped.

Sohthit (bird trap) : One of the most common methods of trapping bird is to smear

pieces of bamboo with the gum of the jack-tree, the former being tied to the branches of some wild fruit tree, upon which, when the fruit is ripen, the bird's legs are trapped on to the gum in the bamboo. This is called ka riam soh thit. Birds are trapped for past time to be kept in cages and hung in the verandahs, sometimes birds are also hunt for food for the villagers.

Bamboo in relation to poultry: The villagers do not discard away old baskets but use them as a nest for hatching chickens by keeping old jute sack inside it so that a hen can sit to incubate the eggs. When this basket can no longer be used, it is dismantled and then used for fuel at home in order for cooking food. Poultry are also kept in coop especially made of bamboo material for the floor and the wall, but for the roof, a palm like leaf called tynriew is used in the same way the bamboo huts are made.

Bamboo as fire wood : Bamboo, thus, contributes to the subsistence needs for the villagers. The dried and waste bamboo that lie scattered in fields and gardens outside the dwelling houses along with wood are used by the people as fuel for cooking food in their houses. Bamboo is also a raw material for making huts and sheds for field products which provides shelter from rain, sun and wind.



Bamboo as firewood









Bamboo Baskets

The processing (splitting, slicing and weaving) works for mat – making is mainly done manually by the female members of the family and machine are not used for this work. The bamboo cut from the forest are left there for some time before further processing. The cutting and slicing of the bamboo is usually done from December to April and the strips are then bundled and stored for mat – weaving, the rest is used as firewood or discarded. The sale of the mats is through the local traders or the middlemen. The middlemen are, the only agents through whom the villagers sell their finished products. The villagers dependence on the middlemen is mainly due to the lack of proper trading channels and transport. (Tiwari et al. 2008).

STRATEGIES FOR CONSERVATION AND SUSTAINABLE UTILIZATION

The following strategies are suggested to address the constraints faced by the bamboo sector of Meghalaya.

Market information

The existing policies often do not take into account the specific problems faced by the producers in marketing of bamboo products. For instance, the main hurdle to marketing of bamboo products is lack of necessary market information, transparency and equal opportunity. The rural poor do not have access to market information like price, peak season, major markets and the consumer's needs and preferences. Thus, to facilitate marketing of products and help the producers, necessary market information should be made available to the rural producers at appropriate time. The National Informatics Centre of the Government can set up a Market Information Center in the districts about the demand of the product, the price of the product at national as well as at international level. This will ensure that all stakeholders have equal access to basic market information. (Tiwari et al. 2008).

MINIMUM SUPPORT PRICE

Apart from taking the bamboo items to the dealers by the craft persons, they also sell the finished bamboo products through the middlemen who take the bamboo goods to the dealers, who belongs to other Khasi villages or those who are from Shillong. These middlemen are the young boys from the villages as they are the ones that always frequently visit the market. Thus by using the middlemen, craft persons having more time for weaving bamboo items at home while the middlemen also have some earning. Sometimes these middlemen enter into mutual agreement regarding profit distribution with the dealers in other villages of Khasi hills and in Shillong. The craft persons, either by themselves or through the service of the middlemen or through the dealers in Shillong also send their bamboo items to traders in places like Delhi, Kolkata and Bangaloru etc.

TRANSPORT

The villagers even though for a very nominal price never refuse selling their products to any coming to see their village area for its name and fame of bamboo goods but because of the difficult terrain of reaching these villages which can be done only by foot. The price of bamboo goods sold in these villages is lesser when compared to the very reasonable in comparison to that sold in the market city. (Tiwari et al. 2008) stated that in most interior villages where basic infrastructure like road and means of transport are lacking, the producers are not able to bring their products to the roadside or main markets. Cost of the transport of bamboo makes it economically less viable, hence they remain under – utilized. However in some cases There is the most common channel of marketing where the villagers set up a temporary store to display the bamboo goods and sell these products on the local market day which is held once in four days at Mawsynram which is the nearest transit point or a place from where they take vehicles to go to Shillong and other places.

COLLECTION/ EMPLOYMENT

The price of an item when sold in Shillong will be Rs.30 or Rs.50 higher than the price in the villages. This is so as transporting the item costs an extra amount of money. Bigger items like winnowing tray, rain shield, cone basket and polo basket the profit margin would be from Rs.30/- to Rs.40/-. Knup (rain shield) is not sold only as a single item but also collectively as a score (twenty pieces) called (shi khuri), the price of which varies from Rs.1500/- for smaller ones to Rs.1900/-for bigger ones for twenty pieces (shi khuri). Making bamboo items in the villages the villagers have a great role to play in giving employment to the people. In a place where people do not dream of being employed by the government and unemployment is not a threat, because handicraft is a way to give employment to the inhabitants. Even if a few individuals are not directly engaged in handicraft works, they are engage as middlemen who carry the finished products for sale. By doing so, some commission is obtained by them at the rate of Rs.10 to Rs. 20 per product for smaller items and Rs.30 to Rs.40 per product for bigger items as told by those young people who are engaged as middlemen. Most people from the villages make and sell bamboo items as individual entrepreneurs. But for meeting the demands of the larger market, the people formed registered societies. The only criterion for becoming members in such societies is that they should have the skill for weaving crafts. Goods woven by the society members should be sold only through the Society they belong.

RATIONALIZATION OF ROYALTY AND TAXES

Taxation policies are not favorable for bamboo production and trade. Rates of royalty levied on bamboo are too high compared to the cost involved in the collection and processing of the same. It reduces the income of the growers.

VALUE ADDITION AND PROCESSING

Bulk of bamboo is sold in raw form and value addition is done outside the State. Another problem faced by the people involved in bamboo collection and trade is their ignorance of the value added processing such as bamboo chips, bamboo ply, etc. There is almost total absence of technologies for processing of bamboo to convert them into high value products. Bamboo shoots can be efficiently dried and pickled since bamboo shoot pickle has a huge demand in international markets. But the local producers and even market players are not trained to produce the value added products for such markets, hence less benefits. Value additions at the village level will also provide employment opportunities besides assuring a higher income to the producers. (Tiwari et al. 2008).

TECHNOLOGY UPGRADATION

In the case of bamboo handicraft and furniture – making, there is a need to upgrade technology so as to enhance the productivity and quality of the finished materials; also to cater to the needs of highend consumers. If appropriate and modern technologies are introduced, bamboo products of Meghalaya can suitably cater to the consumer's needs and can also successfully compete with other manufacturing units present in the national and international scenario.

SKILL IMPROVEMENT AND CAPACITY BUILDING

The producers have the basic necessary skill required in many areas like furniture and handicrafts making and processing of edible items. However, to cater to the needs of the diverse consumers, skill up-gradation and capacity building is essential. Training and exposure trips from time to time can improve their expertise in these areas. Such skill formation and up-gradation according to the changing need of the market is essential to remain a key player in the highly competitive market of a globalized economy.

CULTIVATION OF BAMBOO

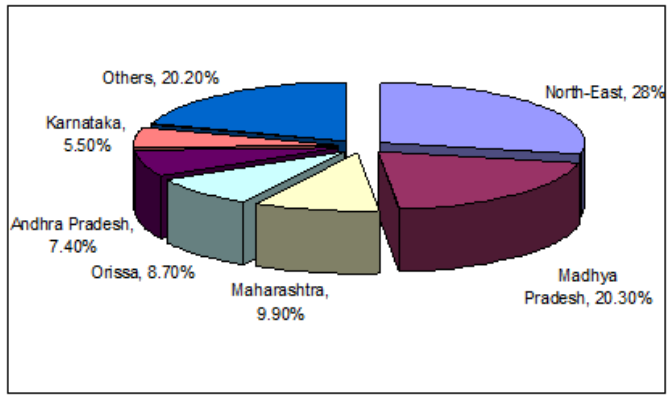
Cultivation of bamboo is picking up in areas where it has become a commercial product. However, this needs to be encouraged and policy and legal impediments in the process need to be removed. This will fetch a better income to the growers; at the same time it will also meet the market demands and serve consumers.

LOCAL INDUSTRIES

More emphasis should be given for the setting up industries for processing of bamboo shoot, so as to cater to the demand not only at the national level but also at the international level. There has been a flourishing market for bamboo plywood in the international markets an initiative in this direction is also desirable. (Tiwari et al. 2008).

BAMBOO RESOURCE AVAILABILITY IN INDIA

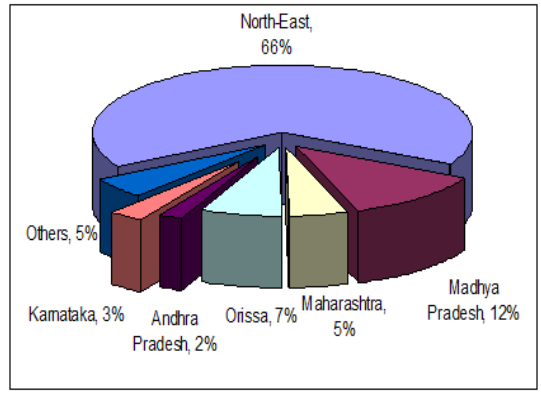
India has the largest bamboo resources of the world with 15.69 million ha bamboo area. Madhya Pradesh maximum bamboo bearing area of 1.8 m, ha followed by Maharashtra (1.6 m ha), Arunachal Pradesh (1.5 m ha) and Odisha (1.2 m ha). As compared to the estimation of FSI in 2011, the total bamboo bearing area in the country has increased by 1.73 m. ha, constituting 16.8 per cent of the total forest area (67.71 million ha) of the country. In India, last decade witnessed a gradual increase of 2.4 million ha area under bamboo resource from 8.96 million ha. Together, with China and Myanmar, India has 17.6 million hectares of bamboo reserves which constitutes 75 per cent of the world's bamboo forests (FSI, 2007; Lobovikov et al., 2007). Of the total area under bamboo in the country, nearly 28 per cent is in the North-Eastern States followed by Madhaya Pradesh (20.3%), Maharastra (9.9%), Orissa (8.7%), Andhara Pradesh (7.4%), Karnataka (5.5%) and the remaining 20.1 per cent is distributed in other areas rich in bamboo are Northern parts of West Bengal, Bastar region of Chhattisgarh, the Western Ghats and Andaman and Nicobar Islands. Around 66 per cent of bamboo resource (growing stock) of the country and 20 per cent of the world are grown in the North-Eastern region (Rai and Chauhan, 1998) (Fig. 1).



(Fig.1)

As per the current assessment by the FSI (2017), the maximum number of green culms are found in Arunachal Pradesh (3121 million) followed by Assam (1848 million) and Manipur (1772 million), while Meghalaya contains 1002 million green culms.

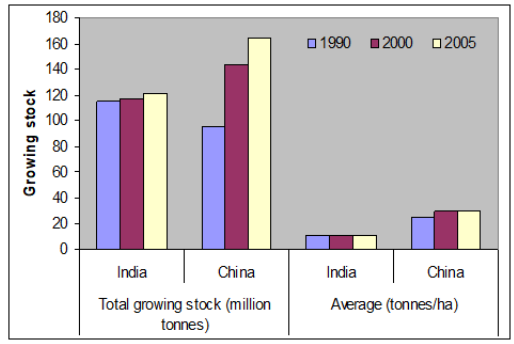
The total assessed growing stock (green weight) for the inventorised area was 80.43 million tones. Of this, 67.3 per cent is by clump forming bamboos and 32.7 per cent by non-clump forming bamboos (Rai and Chauhan, 1998). The main states/UTs that contribute (66%) growing stock i.e. Assam (16%), Manipur (14%), Meghalaya (6%), Mizoram (14%), Arunachal Pradesh (12%), Madhaya Pradesh (12%), Orissa (7%), and Maharastra (5%), Karnataka (3%), Andhra Pradesh (2%) and others (5%). (Fig. 2).



(Fig.2)

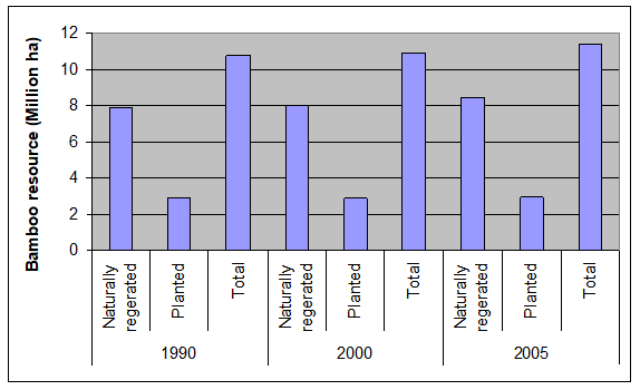
Commercial growing stock, defined as part of the growing stock available for harvesting after one year, constitutes about 13% of the total growing stock. Although, India has larger area of bamboo than China, yet its total and unit growing stock per ha are relatively lower 75% and 30% respectively due to heterogeneity in species composition (Lobovikov et. al., 2007) (Fig. 3).

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(Fig. 3)

Nearly 3 million ha area constituting around 25% of the total bamboo area of the country is planted. The ownership pattern of the bamboo resources in the country revealed 16% area as private and 84% as government forest (FAO, 2006). The share of planted bamboo remained stable, while the total area of bamboo gradually increased.



(Fig.4)

BAMBOO MARKETS OF THE COUNTRY

Bamboos are normally marketed either as commercial bamboos or as industrial bamboos. There exists no standard or generalized system of classification for industrial and commercial bamboos (Bhojvaid, 2005). The former are produced from live culms which are 2.5 m to 8 m in length and have 15 cm to 30 cm basal girth. The bamboo culms which are less than 2.5 m in length and have basal girth lower than 18 cm are generally used for industrial purposes. However, different systems of classification are followed in various regions of the country. For instances, in government markets of Northern India, bamboos of 2 m and 1 m length, are sold in the name of *bahi* and *sarava*, respectively, while in private markets the bamboos of different length are sold in the name of *kauri* (bundle of 20 bamboo culms). The price of commercial bamboo varies from Rs. 30 to Rs. 100 per culm (1 US$ = Rs.66) depending upon its length, girth and rigidity. The price of industrial bamboo varies between 2000-3000 rupees per ton in various timber markets of the country (Timber/Bamboo Trade Bulletin, 2007). The major markets of the country and prices of bamboo prevailing in these markets are given in Table 29.

Table 29: Production of bamboo in the country

S. No.	Units	Bamboo production	
		2000-01	2001-02
1.	Metric tones	290133.9	261919.3
2.	Cubic meters	224819	191152
3.	Running meters	936000	611952
4.	Number (culms)	24840427	21982765
5.	Notional tones	182206.1	174822.2
6.	Lakh NTAD	24.26	137.11

Bamboo Markets: It has been estimated that in the world market of bamboo, the combined value of internal and commercial consumption is of US $ 10 billion. The total revenue based products is estimated as Rs. 25,000 crore. Of this bamboo shoots accounts for Rs. 17,500 million which is about 35% of the total commercial market for bamboo based

products. While domestic market for bamboo shoots is valued at Rs. 4.8 crore only. In the North-eastern region of India, where more than 50% of total bamboos of the country are available, the consumption of shoots is largely restricted to use by tribal families (Anon. 2003).

Million tones of bamboos are utilized in different types of cottage industries such as agarbatti, chopsticks, toothpicks, kite frames, cracker industry, ice-cream industry and match industry. There are about 10,000 units in the hand made sector of match industry. The current size of the bamboo in agarbatti market is approximately Rs. 135 crores. Beseies the aggarbatti industry, some other miscellaneous items such as lathis and fishing rods, which are valued at Rs. 186 crore (Anon. 2003). Bamboo craft sector generates about 250 million days of work by employing mainly women from the rural and tribal areas with an income of Rs. 15 billion a year.

It is found that from four tones of bamboos nearly one tonne of pulp is produced which is utilized in different furnishers for production of paper and board. About 1.4 million tonne bamboo per annum is used by 10-15 paper mills (Kulkarni and Rao, 2002). The total production of paper and paper board is estimated to be about 3.1 million ton/ annum. The total import bill during 2000-01 was Rs. 3300 crores making an increase of 10% over the previous year (Anon. 2003).

There is a high demand of bamboo in different markets. It is normally marketed either as commercial bamboo or as industrial bamboo. The former is produced from live culms which are more than 2.5 m in length. The bamboo pieces which are less than 2.5 m in length are classified as industrial bamboo.

According to Bisht (2010), *Teinostachyum dullooa* (*Schizostachyum dullooa*) due to its thin walled culms and long internodes, it is extensively used for making kite frames and sent in large quantities to various parts of the country specially U.P., Delhi, Gujarat and Bengaluru where kite flying is a popular sport.

Its marketing economics were worked out at Jiribam, a subdivision of Imphal East District of Manipur where it was observed that the traders purchased raw bamboos @ Rs. 4.00 per culm from the local intermediaries. After that culms were cut at the nodes, the nodal portion was removed from both sides as it is quite hard and not suitable for making kite frames. Normally three grades are made based on the length of internode i.e. 45cm, 45 to 60cm and above 60cm. After segregating the culm cuttings, 3 to 4 cuts are made at one end of the culm and it is pressed transversely to make it flat thus to reduce the space required for their transportation. A bundle is made by tying 20 to 30 such nodal cuttings. Two to three culms are required to make one such bundle, and approximately 1,200 to 1,400 bundles are transported in a truck. Labourers were paid @ Rs. 100.00 per day, and approximately 50 mandays are required for making one truck load of material. The profit margin of the contractor at Jiribam is around Rs. 3.00 to 4.00 per bundle or Rs. 3,500 to Rs. 4000 per truckload of material.



Dullooa bamboo for transport

The cost of one truckload of dullooa bundles was estimated around Rs. 23,400/= at Jirighat. The local people sell bamboo culms to some intermediaries at their village @ Rs. 2.50 to 3.00 per culm who in turn sell it @ Rs. 4.00 per culm at Jirighat. The transportation charges from Jirighat to Kolkata and U.P. were to the tune of Rs. 30,000/= and Rs. 45,000/= per truck, respectively, which indicated that one truckload of material cost approximately Rs. 53,400/= at Kolkata and Rs. 68,400/= in U.P. The details of the calculations are mentioned below:

Items		**Average**	**Cost (Rupees)**
Cost of one culm of dullooa bamboo at Jirighat	Rs. 2.00 to 3.00	2.50	4.00
No. of culms required for making one bundle	2 to 3	2.5	
Number of bundles transported in a truck	1,200 to 1,400	1,300	
Number of culms required for making 1300 bundles		3,250	13,000.00
i. Labour cost for making 1300 bundles	50 mandays	Rs. 100/man-day	5,000.00
ii. Dredging of culms from Jiri river			
iii. Cross cutting of the culms at the nodes			
iv. Grading of culm cuttings			
v. Making of bundles			
Royalty paid by the contractor	3,250 culms x (0.30 + 0.18)		1,560.00
Sale price of one truck load at Jirighat	1,300 bundles x 18.00		23,400.00
Profit margin of contractor (per truck load)	23,400.00 – 18,000.00		3,840.00
Average value of single culm after local value addition at Jirighat	23,400 / 3,250.00		7.20
Transportation cost from Jirighat to Kolkata			30,000.00
Cost of one truck load of bundles at Kolkata	23,400.00 + 30,000.00		53,400.00
Average value of a single culm at Kolkata	53,400.00/3,250.00		16.43

There are well established markets of bamboo in the country. Some of these are listed in Table 31.

Table-31: Important Bamboo Markets in India.

STATES	MARKETS
Andhra Pradesh	Chittoor, Hyderabad, Janaram, Karimnagar, Kothagudem, Mancherial, Rajhmundri, Vijayawada, Warangal.
Assam	Dhoraj, Jetpur, Junagadh, Prikia
Bihar	Dalotganj, Ranchi
Gujarat	Amreli, Sonagrh, Umarpada
Haryana	Chika, Ismalabad, Kurukshetra, Kaithal, Ladwa, Peohwa, Pundri, Radhaur, Shahabad, Thanesar.
Madhya Pradesh	Akaltara, Bilaspur, Jabalpur, Mungeli, Ratanpur
Maharashtra	Bombaya (Thane), Ballarshah, Chandrapur, Nagur
Odisha	Jeypore, Rayagada
Punjab	Ajnala, Amritsar, Hoshipur, Jalandhar, Kapurthala, Ludhaina, Pathankot, Patti
Tamilnadu	Andhiyor, Denkamkotta, Dharampuri, Gobichettipalayam, Punjai, Puliampatry, Punjai Piliampatti, Sathymanagalam, Salem Town, Salem, Trichur, Tripathur, Trichirapalli
Tripura	Agartala, Dharamnagar, Udaipur
Uttar Pradesh	Jhansi, Jwalapur, Kanpur, Ramnagar, Tanakpur
West Bengal	Calcutta

Although extensively traded throughout the country, bamboo does not have a well established market price. It varies from state to state. India has been exporting bamboos on a large scale. The export of bamboo as raw material is generally not permitted but its products are allowed to be exported as well as imported.

Departmentally harvested bamboo is transported to sale depot for auction and to different departmental outlets for local people for their domestic and occupational uses. There are traders and purchasers from departmental sale depots who convert the bamboos into marketable sizes as per the demand of the consumers. Bamboos on private lands are sold to the consumers on negotiable rate between producer and consumer. In some states, where bamboo is a nationalized produce, it is sold to forest departments by private producers on standard market rates. However, where bamboo does not come under state trading monopoly, it is sold by cultivators and growers through market channels (Singhal and Gangopadhya, 1999). Information on different channels of production to consumption of bamboo in different parts of the country showing market channels statewise, mode of marketing and constraints experienced in marketing is given below.

Table-32: Market channels of bamboo and constraints

States	Market channels	Mode of marketing	Constraints experienced in marketing
Himachal Pradesh	Depots of HPSFC	Open auction	Lack of proper competition, buyers are mostly people from same place. Bamboo reaches market after Diwali when prices are low.
Karnataka	Forest Department Sale	Sold from Forest Depots	Transport and decay during storage.
Kerala	Kerala State Forest Department	Sold from Forest Depots.	Fluctuation in rates of raw material.
Madhya Pradesh	Paper Mill, Industries, SC/ST Corporation. Open market (commercial bamboo)	Agreement with the Forest Department and direct purchase from the private growers.	-
Maharashtra	Bamboo sale is periodically done in open auctions held at various Govt. Depots.	Traders purchase bamboo from the auctions and sell them in open market.	The prices of bamboo are modulated by the timber associations.
Pondicherry (UT)	Private merchant, cooperative society.	Wholesale and Retail.	Storage of bamboo, transportation, seasonal changes in rates of raw material.
Tamil Nadu	Retail outlets. Wholesale dealers through cooperative society, sericulture department.	Domestic and industries.	Fluctuation and variations in price from season to season and place to place. Lack of transport facilities and shortage of raw material.
West Bengal	Building construction Companies, Household use, Paper pulp companies, Handicrafts Companies/individuals	Contract and bargaining. Local purchase. and bargaining. (Producer to middle men to retailer to purchaser).	Small and diffused markets. Due to poverty of the grower, the latter suffers most. Communication gap between the producer and seller.

Bamboo is a raw material not only for big industries, like paper and pulp but also for cottage and small scale industries. A large number of people from poorer sections of the society depend on bamboo for their daily livelihood. In Madhya Pradesh alone nearly 40,000 basods depend entirely for their livelihood on Bamboo. The people engaged in bamboo and bamboo crafts are men, women and children of different age groups (Singhal and Gangopadhya, 1999).

ECONOMIC RETURNS

The expenditure for raising per hectare plantation has already been fixed by National Bamboo Mission (NBM). Thus for bamboo it could start earning by 5-6th years. These returns are expexted to be generated from the sale of raw material. There is immense potential and scope for value addition.

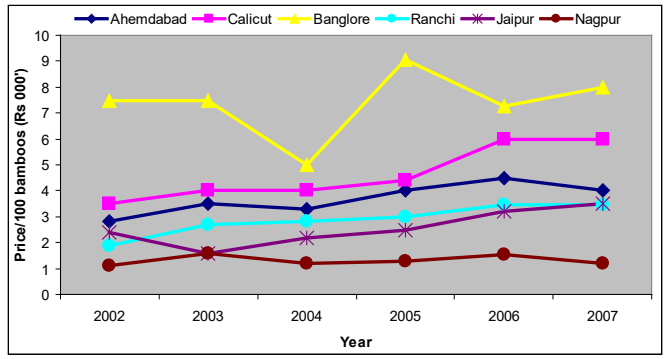
Expected Economic Return from Per Hectare/Year (400 Clumps)

- Culm production per clump per year (Under properly managed condition)	=	20 Nos.
- Number of Clumps per hectare (5 x 5 m) spacing	=	400 Nos.
- Culm production per hectare per year	=	8000 Nos.
- Cost of 1 culm (averge)	=	Rs. 20/-
Therefore, total return from sale of 8000 nos. of bamboo culms per hectare 8000 x 20	=	Rs. 1,60,000/-
Additional income by sale of 100 Nos. of rhizomes @ Rs. 30/- per rhizome in one year 30 x 100	=	Rs. 3,000/-
By sale of bamboo shoots @ Rs. 5/- per 2 shoot for 400 shoots per year 5 x 200 Nos.	=	Rs. 500/-
Grand total (Economic return from per hec./year)	=	Rs 1,63,500/-
Expenditure per hectare (as per NBM in forest area)	=	Rs. 25,000/-
Expected Net profit from per hectare plantation after 6th year = 1,63,500 – 25,000	=	Rs1,38,500/-

(**Source:** SFRI Information Bulletin No.:25

PRICE TREND OF BAMBOO

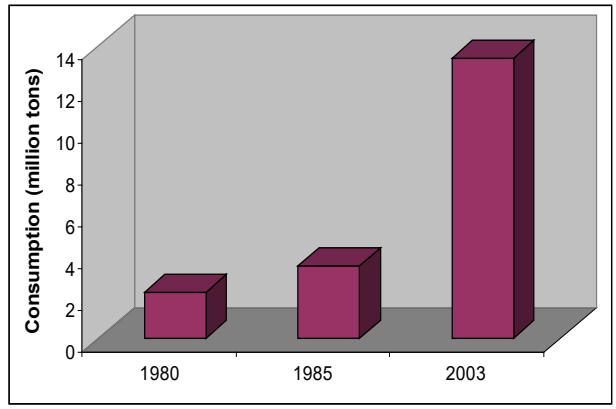
Although bamboo has always remained a preferred material by various consuming sectors, yet its price trend shows steady increase during the last six years. It can be attributed to the poor quality of the stock and uncertainty in the availability. Results of price trends compiled from ICFRE, Timber Trade Bulletin revealed prominent fluctuation in few markets only, while in most of the markets the price of bamboo was observed to be increasing gradually (Fig. 5).



(Fig. 5).

DEMAND OF BAMBOO AND BAMBOO PRODUCTS

Bamboo provides a cost effective, safe and environmental friendly alternative to wood (Anon, 1976). The consumption of bamboo has increased considerably from 2.2 million tones in 1980 (Varmah and Bahadur, 1980) to 13.48 million tones in 2003 (Planning Commission, 2003) due to the rapid growth of bamboo based industries in the country (Fig. 6). There is huge gap between the current demand (26.9 million tones) and supply status (13.48 million tones). The low supply is attributed to a number of reasons like low level uses, poor productivity (4 tones/ha/year), location of industries away from the bamboo growing areas, high transportation costs, wastage of quality material, lack of technology for use of inferior bamboo and unmatched use of species, *etc.*



(Fig. 6)

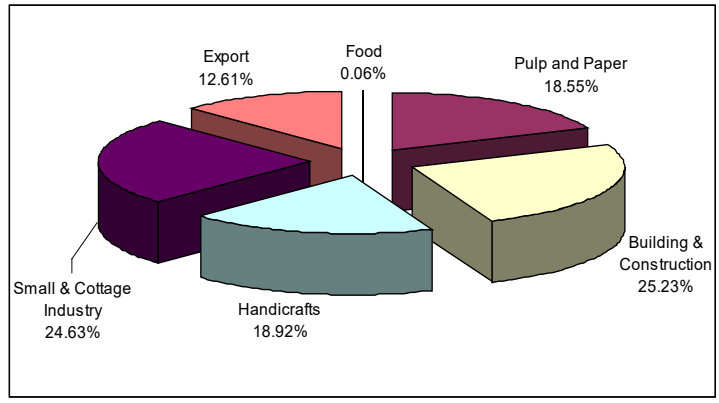
Presently the largest consumer of bamboo in the country is construction sector (3.4 million tones). Sizeable quantity of bamboo is also used by small and cottage industries (3.32 million tones), handicrafts (2.55 million tones). Of this total supply, only 2.5 million ton is consumed by the pulp and paper industry in a year. Nearly one million ton of bamboo is used by ice-cream, kites and crackers industries and also for other miscel-

laneous items such as *lathis* and fishing rods. Bamboo shoot industry is estimated with lowest consumption of bamboo (8200 tones).

There are 666 units of pulp and paper industries distributed all over the country (TEDDY, 2005). These industries were operating at their 41 % capacity using only 2.5 million tones of bamboo (Tewari, 1992). Most of these industries were running at low level because of poor availability of raw material. The pattern of consumption of raw material in these industries includes waste paper (28%), bagasse and agriculture residue (32.3%) and wood (39.3%). Presently, the proportion of bamboo used is only 20 % of wood however, if available round the year, industry can use bamboo as wood substitute due to its suitability, low cost and role in production of good quality paper. With one per cent rise in per capita income demand for paper increases by 1.5 %. With India's per capita income on rise, per capita paper consumption is expected to increase from 4.15 kg in 2002-04 to 8 kg by 2010 and 8.75 kg by 2015 requiring additional supply of bamboo which would be three times to its present consumption (Bihani, 2001; Bhati and Jha, 2006).

Based on the reported consumption of industries engaged in the production of paneled product, Ganapathy (1997) projected the wood raw material requirement by the panel industries for the year 2000, 2005 and 2010 at 2.41, 3.17 and 3.93 million m^3, respectively. These estimates were made by assuming 80 per cent capacity utilization. Even taking into account the 30 per cent market penetration by bamboo-based wood substitutes by 2010, there will be a requirement for around 300 manufacturing units of 200 boards (8' x 4' x12 mm) per day capacity.

Besides this, demand of bamboo is also increasing for new generation products viz. laminates, flooring, boards and ply, truck bodies, railway coach, activated carbon, etc. and medicinal products as bamboo has been identified to have medicinal value to cure kidney disorder, asthma and cancer ailments (Fig. 7).



(Fig. 7).

SUPPLY OF BAMBOO

Out of the total growing stock of 80.42 million tones only 13.48 million tones could be made available to various industrial and commercial users, indicating that so far, we could explore only small portion of our vast bamboo resource. About 28 % of the total bamboo area of the country is located in North-east India having 66 % of the total growing stock. Maximum bamboo for various industrial uses is supplied from North-eastern region. To the total pool of bamboo supply Madhaya Pradesh, Orissa and Maharastra are the major bamboo producing states after the northeast. Their per cent contribution in the total supply of bamboo is 12, 7 and 5 %, respectively, while Andhra Pradesh and Karnataka were recorded with a share of 3 per cent and 2 % respectively. Rest of the country contributes only 5 per cent in the supply pool of bamboo (Table 33).

Table 33: Status of demand, supply and demand gap of bamboo industries (million tones)

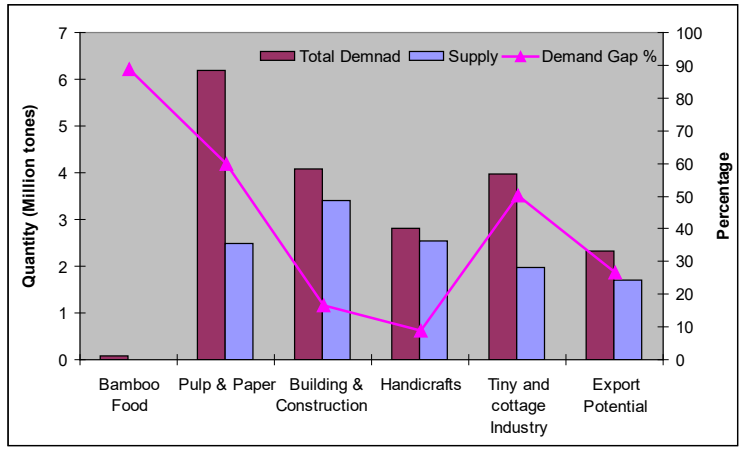
S. No.	Industry	Total demand	Supply	Difference	De-mand gap %
1	**Bamboo food industry**				
(a)	Bamboo shoots	0.0732	0.0082	0.065	88.80
2	**Bamboo wood industry**				
(a)	Bamboo flooring	0.35		0.35	
(b)	Bamboo board	3.12		3.12	
(c)	Bamboo pulp	6.2	2.5	3.7	59.68
(d)	Bamboo furniture	1.4		1.4	
3	**Building and construction sector**	0			
(a)	Scaffolding	4.08	3.4	0.68	16.67
(b)	Housing and temporary structures	0.5		0.5	
(c)	Roads	0.6		0.6	
4	**Handicrafts sector**	0			
(a)	Handicrafts	2.8	2.55	0.25	8.93
5	**Tiny and cottage industry**	0			
(a)	Agarbattis, matchsticks, pencils, looms	3.97	1.97	2	50.38
(b)	Other internal consumption	1.35	1.35		
6	**Bamboo joint venture with neigh-boring countries**	0			
(a)	Export to neighboring countries	2.32	1.7	0.62	26.72
Total		**26.763**	**13.478**	**13.285**	**49.64**

DEMAND-SUPPLY GAP

According to Ganguli (2000), India faces severe shortage of wood supply from its forest owing to poor productivity. The demand gap for timber including softwood and hardwood was estimated to be 50 % in 2000, which is expected to remain 25 % by 2010 and 34 % by 2020. The gap is estimated to be shortening in future due to development and availability of wood substitutes. Among such alternatives, bamboo is seen as the best options due to its versatility and applicability to diverse uses. However, in the present scenario, sectors consuming bamboo are also confronted with the shortage of bamboo supply. The demand-supply gap for bamboo followed the same pattern as noticed in case of hardwood and soft wood. The supply from all sources could meet only half of the total bamboo demand of various sectors. The total demand and existing gap is presented in the Table 34.

Table 34: Expected growth of bamboo based industries in the country

Industry	**Quantity required (million tones)**	**Additional quantity required (million tones)**	**Growth (%)**	**Current size of Industry (Rs. in crore)**	**Size of industry by 2015 (Rs. in crore)**
Bamboo shoot	0.08	0.065	25	4.8	4272
Bamboo flooring		0.35	50		1949
Bamboo board		3.12	10		3408
Handicrafts	2.55	0.25	50	765	4312
Paper	2.5	3.7	5.5	250	2088
Scaffoldings	3.4	0.68	9	340	861
Small industries	1.97	2	20	394	3103
Housing and temporary structures		0.5	15		1163
Internal consumption	1.35			33.75	58
Export	1.7	0.62		255	1298
Roads		0.6	25		1069
Wood substitutes		1.4			3260
Total	**13.55**	**13.285**		**2042.55**	**26841**



(Fig. 8)

Bamboo Propagation Methods

The data show that most of the bamboo based industries are not operating to their full potential due to shortage in supply (Table 32, Fig. 8). Bamboo shoot industry has been estimated with maximum demand gap percent (88%). It is considered as the most promising sector of bamboo industries which is likely to touch the level of Rs. 4223 crore by 2015. Pulp and Paper industry was estimated with % cent demand gap followed by tiny and cottage industry, export industry and building and construction industry where demand gap was estimated to be 50.38 %, 26.72 per cent and 16.67 %, respectively. The least gap in demand and supply was observed in handicraft industry which was recorded to the tune of 8.93 % only. (Fig. 8).

There is a growing realization that the potential of bamboo in the country has not been tapped to its fullest. However, the gap between demand and supply is expected to shorten in near future owing to increased attention towards production potential of Indian bamboo reserve, incentives to invest in raising new plantations, commercialization and promotion of value-added bamboo products, etc.

CONSTRAINTS IN THE PROCUREMENT OF RAW MATERIAL

Despite large reserve and diverse germplasm, availability of raw material is very poor in the country. The main reasons noticed for the poor availability of bamboo includes:

- Lack of application specific quality material is inhibiting the development of value added applications and enterprises.
- Inaccessibly to the natural plantation areas due to difficult penetration, high transportation cost and lack of proper pricing mechanism.
- Lack of management practices to ensure quality and sustainable yield, improved harvesting, preservation and treatment, grading, *etc*.
- Inconsistent supply and poor quality
- Inadequacy of the system to extract and make full use of large volume of bamboo availability from large gregariously flowered bamboo areas especially in Northeast India
- Inadequacy of policies to promote the bamboo as a commercially viable industry. Policy interventions are required to encourage the import substitution and export promotion of bamboo and bamboo based products.

FUTURE STRATEGIES

Existence of fairly large gap between demand and supply requires immediate attention to boost the production of bamboo in different parts of the country. Issues related to proper management to tap the bamboo resource available from largre gregariously flowered area, transportation costs, productivity, quality of raw material, etc. are needed to be addressed effectively (Pande and Pandey, 2008). All these measures require careful planning and implementation. Bamboo in addition to massive plantation in forest areas, should also be promoted as component of agro-forestry system and as an agri-horticultural crop as it is amenable to annual harvesting, particularly edible shoots. The strategies to bridge this gap should be well defined, locality specific, oriented to increase the productivity as well as area under bamboo plantation (Kishwan and Goyal 2006).

SYNCHRONIZATION OF BAMBOO RESOURCE GROWTH WITH INDUSTRIAL GROWTH

The bamboo industry in the country is likely to grow at a compounded annual growth rate of 15 % from the year 2001 to 2015 (Planning Commission, 2003). The highest growth is expected in bamboo shoot processing and bamboo flooring industries. A growth rate of 5.5 %, 9 %, and 20 % per year is expected in the paper, scaffoldings, and pencil industries, respectively. Similarly with the acceptance of bamboo as a structural

material, its usage in road and housing construction, which may increase at the rate of 10-15 % in the initial years is likely to go up to 20 % after a few years. The acceptance of bamboo as wood substitute and of bamboo board as a substitute for plywood, is likely to lead to a growth rate of at least 25 % per year, since the present low usage is primarily on account of low awareness.

INVESTMENT TO RAISE NEW PLANTATIONS

There is in fact a severe shortage of quality bamboo materials. Hence, the need for new bamboo plantations, in the form of 'industrial plantations' to raise special purpose/species needed by the industry or crafts have to be identified. State-wise new areas should be selected to raise industrial bamboo plantations. Lack of technologically sound programmes and incentives are the major causes in raising new plantations. In the present scenario, private plantations are being raised primarily as wind break to secure protection to mango orchards, agricultural crops, soil conservation, and to meet the need of domestic consumption and construction sector, while commercial motives to raise bamboo on private land is still a far cry. To meet the growing demand of bamboo industry in the country plantation stock on both government as well as private land should be increased by integrating the plantation programmes with employment generations and other community developmental works. National Bamboo Mission, realizing the importance of increasing bamboo resources has proposed the expansion of 1.76 lakh ha bamboo plantation both in forests and non-forest areas during XIth Five Year Plan (NBM, 2006).

IMPROVEMENT IN BAMBOO RESOURCE PRODUCTIVITY

The productivity and quality of natural bamboo forests of the country is poor due to lack of cultural operations for clump management, irregular schedule/cycle of harvesting the mature culms, unskilled manpower and financial limitations to undertake cultural operations in bamboo plantation. Currently, the productivity of bamboo forests in the country is only 4 tones/ha/years. It is to be increased to the level of 18 tones/ha/year to bridge the large demand supply gap (NBM Document, 2006). The NBM proposed the stock improvement and management programme for the next Five Year Plans to upgrade the existing plantation stock and improve the productivity. It is targeted by the mission to produce 3.02 million tones of bamboo per year from 4th year of completion of plantation targets.

VALUE-ADDED PRODUCTS

Slight value addition at source would not only increase the profits of growers but also minimize the transportation cost. Looking at the growth of bamboo value added products (15% compound annual growth rate) the small processing units should be established in the vicinity of bamboo producing areas. The most appealing aspect of the industry is that with a few simple forms like slivers, round strips and splints, numerous value-added applications can be achieved at local level by spending very little amount.

SETTING UP BETTER MARKETING FACILITIES

The modern approach to foster the marketing of forest products relies upon the sound and effective information management system. However, given the present bamboo markets situation, lack of knowledge of nature of operation make the producer's interests unsafe. Beside this, bamboo markets, monopolized by big traders, offer little benefits to the market segments operating at lower levels. Absence of common interface to exchange information complicates the situation reflecting inability of various market functionaries in taking decisions and devising strategies of proper marketing. Development and establishment of Market Information Services (MIS) that can provide information and common interface to the bamboo stakeholders, hold the keys to overcome the existing complex situation of bamboo marketing. Regional markets of bamboo should be established. National Bamboo Mission, look to establish new 195 *bazaars* (markets) for providing better marketing facilities to the growers of bamboo. It should be done on priority basis as the better marketing regimes act as the soul of the development. Markets should be studied to identify the main aspects like input supplies, expected output increase, market potential (demand) and capacity of marketing system to handle increased output and anticipated government interventions.

MECHANISM TO UTILIZE BAMBOO OF GREGARIOUSLY FLOWERED AREA

Large volume of bamboo become available in gregariously flowered areas. But due to inadequacy of mechanism and strategies of utilization such big volume goes waste without being tapped for contributing to the industrial demand (Kishwan and Goyal, 2006). A data base on bamboo plantation area and their probable time of flowering should be prepared to formulate strategies to absorb the huge bamboo material produced from such regions.

MORPHOLOGY

Bamboos are the giants of the grass family Poaceae (Gramineae) belonging to sub-family Bambusoideae. The bambusoid grass do not comprise only grasses whose culms are lignified called "*Woody bamboos*" or simply bamboos, but also herbaceous bamboos or bamboo allies. It is estimated that of 25 genera and 130-160 species belong to herbaceous bamboos, which are confined to the tropics and sub-tropics of South America. From India uptill now three herbaceous bamboos are known viz. *Leptaspis urceolata* (Roxb.) R.Br., from Kerala; *Phaenosperma globosa* Benth., from Arunachal Pradesh and Sikkim and *Streptogyna crineta* P. Beauv. from Kerala (Naithani, 1993).

Bamboo, popularly called "Tree Grasses", attain heights upto 46 m e.g. *Dendrocalamus giganteus* in China (Guiness Book Records, 2006) and upto 30 cm in diameter (e.g. *D. sinicus*). However, diversity is not lacking in bamboo, as species like the American genus *Raddiella* are quite delicate and only a few centimeters in height. In India, *Kuruna densifolia* (Munro) Attigala, Kaththriarachi & Clark (*Arundinaria densifolia* Munro) from South India is hardly one metre high and only about a centimeter in diameter.

A Bamboo plant is a complex system, with many parts. Of its component elements, the culm, rhizome, nodes, branches, buds, roots and seeds play defined and important roles in propagation.

The bamboo plant – unlike trees, which have a central trunk or main axis – consists of two sets of axes: one above the ground and the other below the ground. Each of these axes is a series of internodal segments, defined and demarcated by nodes.

- The primary overground axis, or terrestrial portion, consists of jointed, tall and cylindrical stems, called culms. Secondary axes, in the form of branches, develop laterally and extend outward from the culms.
- The underground axis is a solid rhizome system with roots and buds.

Rhizome: The rhizome is the underground portion of the bamboo. It expands laterally under the soil surface, extending the domain of the plant, and enlarging and consolidating its area. Bulbous in appearance, each individual segments of the rhizome tends to taper towards its end to form a 'neck', which connects it to other segments. The rhizome is a store of food and nutrients that are accumulated in the plant's periods of dormancy, and utilized in growth periods to expand the plant system. Its shape, length and relative morphology changes with clump-forming (sympodial) and non-clump-forming (running or monopodial) bamboos. The rhizome too has nodes and internodes, which are covered by sheaths. Roots that forage for nutrition emerge from the nodes.

Nodes and Internodes: The rhizome, culm and branches of the bamboo are segmented by solid nodes. The nodes are growth points from where new vegetative axes develop.

The portion between two successive nodes is called an internode, and its length varies considerably across species. The internodes, which are usually hollow, are covered by sheaths at the initial stages of growth; these sheaths fall off as the plant matures. The cells in the internodes are arranged vertically, along the culm, to act like water pipes that conduct water and nutrients upwards. The cell elements in the nodes, on the other hand, are horizontally oriented, enabling transverse movement of water and nutrients.

Culms: The most visible and easily recognizable feature of the bamboo is its culm, or stem. It is also the most widely used part of the plant. In most bamboo species, the culm is a tall, woody and hollow cylinder that tends to taper towards the top. Culms of sympodial bamboos are clustered in clumps.

Culms have distinct and solid nodes by which they are segmented into internodes. Each internode bears a branch bud (or primordium), which may develop into branches and branchlets that, in turn, bear leaves, flowers, fruits and seeds.

Buds: Buds emerge on alternate sides of the axes on the culm and rhizome of the bamboo. Culm buds are located marginally above the nodes and rhizome buds are seen adjacent to the nodes, in the internodal portion. Buds are the key points from where new axes emerge, and from which, in propagation activities, an entirely new plant system can be formed. New rhizome axes, as well as shoots that grow into culms, emerge from buds on the rhizome. Culm buds occur varyingly across species, from the lowermost node upwards or from the mid-culm upwards.

Roots: Roots provide anchorage in the soil, and make possible the uptake and distribution of water and nutrients to other parts of the plant. Roots grow from the nodes of the rhizome and of the underground portions of the culm. In some bamboo species, roots may also appear on the overground portions of the culm and branches. The root system is shallow but a prolific lateral spreader.

Branches: The branch system of the bamboo plant is often characteristic of a species or genus. It consists of one main branch, and secondary branches that may emerge from its basal portion. The main and secondary branches may in turn bear branchlets. A bamboo culm begins to develop branches only when it has reached its full, or almost full height. Branches emerge from buds on the culm, and are arranged alternately along its length. The base of a branch may develop a rhizomatous swelling and root primordium, which help in vegetative propagation through branch cuttings. This can be induced by chopping the culm tops and removing newly emerging culms from the clump.



Rhizomes



Nodes



Internodes



Culms



Bud



Roots

Leaves: The branches and branchlets of the bamboo plant bear leaves. These are important elements in photosynthesis. They also protect the plant against the elements, in frost and rain. For example, most bamboos produce profuse leaves that fall to the ground annually, forming deep carpets of nutritious organic matter. They are also a good source of fodder.

Culm-sheaths: These are the sheathing organs that are attached at nodes. In the axils of each culm-sheath is a bud that may grow out into a branch. The function of culm-sheath is to protect a bud. These are the modified leaves, and have the same parts as leaves. When the sheath is old it usually separates from the node leaving the scar. Culm sheaths are, more or less, distinctive for each species of bamboo. The general appearance, size, texture and shape of the sheath and their blade afford good character for distinguishing the different species.

Flowers/ Fruits, Seeds: Bamboo flowers tend not to have petals, but may have small scale-like flaps at the base. Bamboos are normally wind-pollinated, and the flowers are structured accordingly, with feathery stigmas. For propagation, the relevant – and dominant – issue is that bamboos flower infrequently, often irregularly and at long intervals. Seed availability is therefore not common.

The fruit in bamboos is an indehiscent (it does not open when ripe), one-seeded structure known as a caryopsis (the outer layer of the seed proper is fused to the wall). Its size varies from that of a grain in *Bambusa, Dendrocalamus* and most other genera; to a small guava in *Ochlandra sp., Melocanna baccifera* and *Melocalamus compactiflorus.*

The fruit of bamboo drop from the plant, and germinate usually with in a week (Kurz,1876). Considering the rapidity of normal germination in the bamboos, it is perhaps not surprising to find that the rather rare condition of true vivipary in two genera viz. *Melocanna* and *Melocalamus.*



Branches



Culmsheaths



Leaves



Seeds



Fruits



Flowers

GUIDELINES FOR COLLECTION OF BAMBOOS

Plant collectors are accustomed to limit their activities to plants in flowers or fruits so those sterile specimens are generally avoided. In case of bamboos, which often flower only at intervals of many years, the collector rarely encounters them in the reproductive state. Both, this fact and the complexity of plant itself accounts for the relatively poor representation of bamboo-specimens in herbaria. However because of this very propensity of bamboos to be seldom found in flowers, taxonomic studies on the group have relied heavily on sterile characters.It is therefore suggested that the Scientists working on bamboos should always collect complete herbarium specimens viz. flowers, leaves, culmsheath and deposit them in any recognized herbarium for to check them authentically. In other words their research reports should be confirmed by voucher herbarium specimens. Even though Bor (1953) stated that for the taxonomy of bamboos forests officers should make it a rule never to pass a bamboo clump in flower, without taking and pressing a specimen of the flowers, leaves and culmsheaths and sending them to the Forest Research Institute, Dehra Dun. In fact a complete vegetative collection is often sufficient to allow identification of particular bamboo at generic, if not specific level.

(i) Material from two distinct plants under the same number, although they probably represent the same bamboo species have chances of admixture.

(ii) Complete specimens should be collected for permanent preservation. To identify a bamboo with confidence, one should have representation as complete as possible, by specimens, photographs and field notes. The specimens which are collected should consist of calm sheaths, leafy branches, branch complements, calm nodes, flowering branches (if any) as well as young shoots.

(iii) Each part collected should be numbered according to the collector's field number.

Calm sheath: Calm sheaths in good condition and complete with blades and auricles if present) should be collected preferably above the fifth node of mature calm and be pressed flat; if too large for the press, they should be cut or folded. If not possible to spread a sheath without breaking it, it should not be pressed but rolled up. To protect fragile parts paper should be tied over tips of unpressed sheaths.

Leaf branches: Twigs or branches with leaf blades of all sizes and ages should be collected and pressed promptly, before the leaf blade curl.

Branch complement: At least one typical example of a branch complement should be collected from the middle of a mature calm. Branches about 5 cm from their base should be cut and segment of calm embracing the selected branch complement be also included. If possible a series of branch complements, from buds to developed one be collected.

Material from two distinct plants under the same number, although they probably represent the same bamboo species have chances of admixture.

Culm node and internode: Segments of mature culms embracing nodes between nodes four or five above ground and the internode between should be collected.
Rhizome: Wherever possible one complete example of a rhizome should be collected showing typical branching habit. Rhizome should be washed and its roots be trimmed and its photograph or sketch be taken.

Flowering branch: As much as possible to show ranges of variation in habit, leafiness, stage of development etc. the flowering branches must be collected and pressed.

Seedlings: Seedlings should be searched under the culm and if found should be pressed.

Field notes: Notes must be written on habit of clump and culm, maximum culm height, culm diameter, length of internode, thickness of culm wall, if flowering whether sporadic or gregarious, locality, habitat, altitude, local names and local uses. Date of collection, name and field number of collector and if possible a coloured photograph of bamboo should be also taken.

FLOWERING AND MORTALITY

The study of bamboo flowering currently is an interesting bedevilling problem for the foresters and scientists. The flowering is very rare in most of the species and historical records are fragmentary, without adequate verification. Brandis (1899) classified bamboos according to their flowering behaviour. A large number of species flower annually; the clump has leaf bearing and flowering culms. In South America, annually flowering species are common, viz. species of *Arundinaria*, *Bambusa* and other genera. However in India and Sri Lanka the number of species known to flower annually is limited e.g. *Bambusa atra* Eastwards to Andaman Islands, *Yushania wightiana* (*Arundinaria wightiana*) from South India and *Ochlandra stridula* from Sri Lanka. On the other hand many of the Asiatic species of bamboo have more prolonged flowering cycle. The intervals between subsequent flowering stages show a wide variation among different species. In some species flowering may occur after 20-30 years, whereas in others it may not appear even after 120-150 years of the first flowering or in some cases the flowering period may be as short as 3 years. The species which are generally designated as regular and gregarious flowering i.e. *Bambusa bambos* and *B. polymorpha* are best examples. Between these two extremes there are numerous species which occupy an intermediate position, as regards their flowering habit under similar environmental conditions. The same species, however, is also found to flower sporadically, and in such case leaf-bearing culms are rarely found in flowering clump, and at times some of the flowering culms bear leaves. Of these intermediate species, which may be termed irregularly flowering, the best example is *Dendrocalamus strictus*. In some bamboos the vegetative structure (parameters) shows signs of persisting indefinitely, by producing new growth with undiminished vigour with the age as reported in the case of *Bambusa vulgaris*. Perhaps such bamboos possess a physiological stability which keep them perpetually in a vegetative state, and which occasionally permits only individual plant under the impact of certain unknown circumstances to produce flower. At any rate the behaviour in *Bambusa vulgaris* suggests such condition. Though it was described in 1810, it has not been observed to flower gregariously. At fixed maturity period bamboo produce seeds and then die. Authors like Janzen (1976), Campbell (1984) and Gadgil and Prasad (1984) have used the term monocarpy in bamboo flowering. Monocarpy means plants bear fruits only once during their life span and then die.

In Mizoram bamboos, flowers in cyclic manner and there are two cycles independent of each other. The first cycle is associated with the flowering of *Melocanna baccifera* which flowers in a 48 ± 2 years cycle (the period of its flowering is known locally as '*Mautam*') and the second cycle is associated with the flowering of *Bambusa tulda* and *Dendrocalamus longispathus*. These bamboos too flower in a cycle of 48 ± 2 years and the period of their flowering is locally known as 'Thingtam'. 'Mau' and '*thing*' stand for bamboo in Mizo language and '*Tam*' means death—the term has originated probably as the bamboos die after gregarious flowering. The gap between these two alternating cycles is 18 and 30 years approximately. The common widespread belief is that at the time of '*Mautam*' and '*Thingtam*' the rat population in the area increases after eating bamboo

seeds. A rational explanation is that where there is bountiful supply of seeds available there is also a large influx of rodents from neighbouring areas. Reproduction in rats is rapid as the well-fed offsprings quickly give birth to millions of young ones. The result is that the rodent population reaches an astronomical figure within a short time in a small area. The following year when there is no bamboo seed available to feed upon, the army of rats attacks the crops and plays havoc in the cultivated fields, jhumlands and homes. In an effort to correlate the relationship between bamboo flowering and rodent population, there are reports that reproduction behaviour of experimental population of rats which were fed bamboo flowers concluded that direct ingestion of bamboo flowers has no effect on the reproduction behaviour of rats. Rats causing damages in the fields have been identified by the Scientists of Zoological Survey of India as *Rattus niviventor* Thomas and *Rattus nitidus* Hintea.

Flowering cycle of some commercial bamboo species is given below:

Species	**Local Name/Khasi name**	**Intermast period**
Bambusa balcooa	Baluka, Borua, Gorua (Garo)	35-40 years
Bambusa bambos	Kanta bans, Wakantha (Garo)	35-48 years
Bambusa cacharensis	Ba (Jaintia)	45±5 years
Bambusa jaintiana	U Skhen (Khasi & Jaintia)	63-83 years
Bampusa nutans	Taksharh,Wasin,Wasim(Garo)	35-40 years
Bambusa polymorpha	-	50-60 years
Bambusa tulda	Jati bans,Rmai (Khasi) Thengrangai (Jaintia), Wati, Wagi, Wage (Garo)	30-60 years
Dendrocalamus asper	Thailand Bamboo	30-40 years
Dendrocalamus giganteus	Giant Bamboo	76 years
Dendrocalamus hamiltonii	Kako Bans,Seijlieh (Khasi), Wanok(Garo)	30-40 years
Dendrocalamus latiflorus	Red Bamboo	40-45 years
Dendrocalamus longispathus	Rupai	25-35 years
Dendrocalamus strictus	Lathi Bans	17-48 years
Drepanostachyum falcatum	Gol Ringal,Namlang(Khasi)	28-30 years
Melocana baccifera	Muli Bans, Tyrlaw, Siejla (Khasi), Water (Garo)	26-50 years
Ochlandra travancorica	Eta	7 years
Pseudoxytenanthera stocksii	Cheva	40-45 years
Teinostachyum dullooa	Dolu Bans,Seijla (Khasi) Wadrow (Garo)	45±2, 35±2, 15±2 years
Thamnocalamus falconeri	Deo Ringal	28-33 years

Thamnocalamus spathiflorus	Tham Ringal	60 years
Thyrostachys oliveri	Burma Bamboo	47-48 years
Yushania maling	Maling	24 years

Bambusa vulgaris, a commercial bamboo, has no record of its gregarious flowering.

NATURAL REGENERATION BY MEANS OF SEEDS

The flowers are generally produced from November to March, and seeds ripen during April and May. The seeds fallen on the forest floor start germination immediately after the rains. If the seeds have fallen in nallah beds and other moist areas they germinate even before the rains. Normally, germination is completed by the end of June. If fire occurs just after the seed fall, the seed is liable to be totally burnt. In well protected areas, germination is profuse and the whole ground is carpeted with seedlings after the rains.

The seedlings come up in millions and severe competition is soon set in amongst them for survival. The thinning out process of nature gradually spaces out the seedlings, leading to their final establishment at respectable distance from each other.



Natural Regeneration by seeds

By means of vegetative parts

Vegetatively the rhizomes proliferate and produce many new culms every year mostly during monsoon period. The culms fall on moist ground, due to natural damage by wind, elephants etc., also sometimes produce new plant by rooting at nodes.

ARTIFICIAL REGENERATION

Collecting Seeds: When ripe, bamboo seeds fall to the ground. At an advanced stage of seed formation, culms may be shaken to dislodge the seeds. This results in cleaner collection of seeds than if they are picked from the ground. Seed collection is easier if the area around the bamboo clump is cleared of other vegetation, and swept clean. Alternatively, a large clean cloth or tarpaulin may be placed on the ground on which the seeds may fall. If it is not possible to do, the fallen seeds should be cleaned – by winnowing (especially for smaller seeds), by removing insects and pests, and by shaking tree dirt and other matter.

Storing Seeds: Although fresh bamboo seeds germinate better than stored ones, appropriate storage techniques can retain the viability of bamboo seeds for a certain length of time. Two storage methods have been found effective: (i) dry storage with control of moisture content, and (ii) dry storage with control of moisture content as well as of temperature. Of these, the first is simpler and is suitable for areas where continuous power supply is a problem. The latter, however, is more effective.

Dry Storage with Moisture Control: Keeping seeds in low humidity conditions slows down respiration and prolongs the ageing process. In this method, the seeds are first dried so that they retain only 8-10% moisture content. Then they are filled in airtight plastic containers, which have calcium chloride spread at the bottom (up to one-tenth the weight of the seeds) to act as a desiccant. Use of excess desiccant carries the risk of over drying. A wire gauge is placed over the desiccant before the seed samples are placed in the container. Sometimes the airtight containers are placed over a desiccators, or the storage room is fitted with a dehumidifier, to limit the moisture content.

Dry Storage with Moisture and Temperature Control: Apart from moisture, temperature also affects the viability of seeds. Lower temperatures result in a lower rate of respiration and increases the life –span of the seeds. Therefore, a combination of moisture and temperature control is more effective to maintain their viability. Depending on the size of the samples to be stored, a deep freeze or cooled room can be used for storage. Seeds brought down to 8-10% moisture content are kept in a deep freeze maintained at -10^{o} to -14^{o} C. This requires uninterrupted power supply; temperature fluctuations resulting in frequent freezing and thawing adversely affect the storage life of seeds.

Precautions

- Seeds should be processed and transferred to storage conditions quickly, to avoid loss of viability.
- Seeds with high viability rates should be chosen for storage.
- Seed samples with fungal or insect damage should not be taken for storage.

Soaking Seeds: Seeds from gregarious or sporadic flowering of bamboo should be sown as soon as possible after collection. The earlier the seeds are sown, the better their chances of germination. Soaking in water improves germination. Therefore, treatment prior to sowing, in the form of soaking the seeds in water overnight or for 24 hours, is recommended.

By Means of Seeds: Bamboo seeds germinate generally within 5-10 days and the percentage of germination is higher when seeds are sown directly in polythene bags than in nursery beds. The viability of seeds varies from species to species but is generally from one to two months, although the period can be increased under controlled storage conditions. Seeds of various bamboo species stored in a tight container over silica gel maintain their viability generally for 1-3 years, in some cases even over a longer period.

In general, seed is the best source of planting material for large scale plantations. Seedlings are more handy than other type of propagules. The superiority of container-raised seedlings over bare-rooted seedlings is well established. As *Bambusa bambos* and *Dendrocalamus strictus* produce sufficient quantity of seeds at one area or another sporadically, and enormous quantity of seeds at the time of gregarious flowering, there is no need to resort to other methods of propagation except when selected genetically superior plants are required. According to an estimate an average clump of *B. bambos* in Karnataka produces 100 kg of seeds and a hectare contains ca 100 clumps. It is also reported that enough seeds are available from sporadic flowering of the village bamboo clumps (*Dendrocalamus longispathus*) for raising plantations.

Seed Sowing: Seeds from gregarious or sporadic flowering of bamboo should be collected, cleaned, graded and sown as soon as possible after collection. The earlier the seeds are sown, better the chances of germination. Seeds can be sown within six months of its collection i.e. from September to March if stored in ideal condition. Sowing is done in germination beds in 5 cm deep furrows made across the beds. A thin layer of soil is used to cover the seeds and beds are watered lightly once in a day. The beds should have facilities for overhead shades. The seeds may be also sown in plastic trays, pots or polythene bags but germination beds provide uniform care, moisture, and fertilization for large number of seeds.

Seeds treatment prior to sowing is done in form of soaking the seeds in water overnight or for 24 hours to break dormancy and water is drained out properly half an hour before sowing. The seeds treatment improves germination. The seeds are also required to be treated with fungicides and insecticides before sowing to reduce damping off and damage from the insects.

Seeds starts germinating after 3-7 days and continue upto 15-25 days of sowing. Seedlings should be left in the germination bed for 2-3 months till they reach a height of 8-10 cm and produce 4-6 leaves. Regular weeding, mulching and watering of beds are necessary.

Pricking Out: The poly bags filling media are prepared by collecting top soil either from the nursery site or nearby area and mixing with river sand and well decomposed FYM or compost in the proportion of 3:1:2 or 2:1:1 depending upon the soil type and fertility of the soil. The potting mixture is treated with insecticide and fungicide one week in advance before filling the poly bags. The required numbers of poly bags of size 15 cm x 22.5 cm 250 gauges are filled and arranged in nursery beds of size 10 m x 1.2 m and supported with splited bamboo strips. Poly bags of larger dimensions should be filled in proportion of 20-25% of the total poly bags filled for casualty replacement. Poly bags should be preferably kept on the polythene sheet to avoid root penetration.

Seedlings should be pricked out and transplanted in poly-bags after 2-3 months of sowing when they reached the height of 8-10 cm and at 4-6 leaf stage. The transplanted seedlings are to be kept in partial shade initially for a month or two and then shifted to open beds. Except for rainy season it needs to be watered regularly, preferably in the evening. Regular weeding is also necessary. Organic fertilizer should be applied to make the seedlings grow healthy. Inorganic fertilizer should be applied only in exceptional cases. Compost incorporated with rotten leaves of bamboo can be a good organic fertilizer because the leaves of bamboo are rich in silica. Seedlings are to be shifted after 3 months locally to avoid root penetration. Six months to one year old seedlings can be used for plantation purposes.

Wild Seedlings: Wild seedlings of bamboo look like rice or wheat seedlings and are often seen on the ground just below the flowering mother clumps. The numbers of seedlings can be very profuse and they often form a thick mat on the ground. Wild seedlings can be collected and brought to the nursery and transplanted to polythene bags containing soil mixed with sand and FYM. At the beginning, seedlings have to be kept under shade for 3-5 days for hardening and then are placed under partial shade. Two to four leaved stage of wild seedlings are best for collection. For better survival in the field, less than one-year old seedlings should not be planted out.



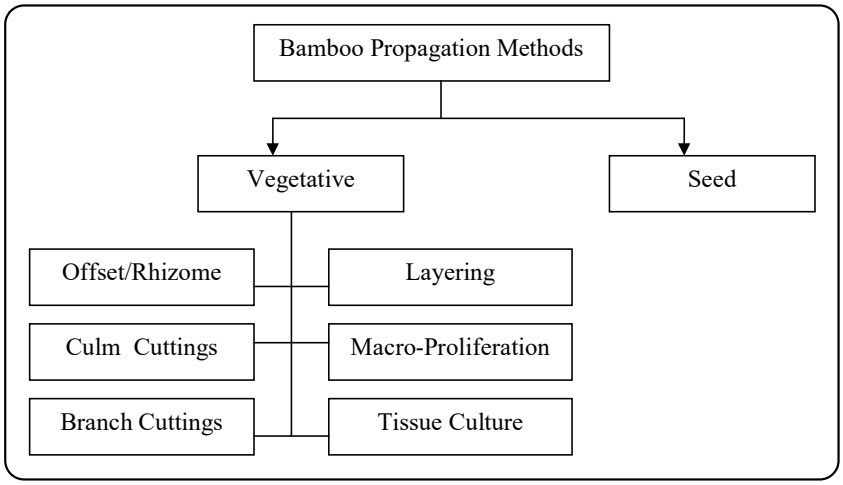
PROPAGATION OF BAMBOO

The selection of superior bamboo species and their multiplication on large scale is in urgent need. Conventional methods of propagation of bamboo are based on seeds and vegetative means. As unavailability of seed is limited to certain specific period only, due to its long interval of flowering, thus integration of both conventional and non conventional methods of bamboo propagation and its management is necessary.

Vegetative propagation

This mode of propagation utilizes the vegetative parts of bamboos namely rhizomes, culms, culm-branches and also the seedlings as propagules. There are many methods followed for vegetative propagation. The use of rooting harmones have now made it possible to propagate many species, by culm-cuttings and branch-cuttings, easily which otherwise normally are difficult to propagate in this manner.

Offsets/Rhizome: Offset planting in the most common and conventional method of propagating village bamboos. The growth of the buds on the rhizome is usually activated by summer in sympodial (pachymorph) rhizomes and by spring in monopodial (leptomorph) rhizomes. Suitable season for planting vegetative propagules, especially offsets and clump divisions, is the beginning of the active growth season of the rhizome buds. In species with sympodial rhizomes the commonest method adopted is offset planting. This method is not suitable for large scale plantation programmes because the availability of rhizomes for any species in general is limited and even if available the cost of rhizome extraction and transportation is appreciably high. Generally offsets from 1-2 year old culms give better results as such rhizomes are vigorous and possess active culm buds; desirable length of the culm is 1-1.5 m. The favourable period for offset planting is one to two months before monsoon, when the rhizome's culm buds are most active. Generally the bamboo species with thin-walled culms provide poor results while the thick-walled species give better results. An offset have only one rhizome and limited number of culm buds. Offset planting is favourable for small-scale village groves.



In India for planting bamboos in homesteads and village groves the above two modes are mostly adopted. Generally in the case of larger bamboos mostly offsets are used and in the case of smaller bamboos clump division is preferred.

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Part – clump planting: The procedure is somewhat similar as the offset method. The only difference is that 2-3 culms with rhizomes are included in a part-clump. Rhizome assembles with 2-3 offsets connected with each other have to be collected at the time as a propagule. This type of propagule is termed as part-culm or rhizome assembly. Such propagules show better performance when collected during April-May. The individual rhizome in a part clump propagule should not be separated during the time of collection from the soil. The culm part of each rhizome should be within the height of 3-4 nodes with viable branch buds. Planting has to be made during rainy season for obtaining the optimum success. As the propagules contain more than one rhizome, the planting pit should be wider size. This method is found to be suitable mostly for thin walled bamboos. The success can be obtained (30-50%) in Muli bamboo (*Melocanna baccifera*) and Dolu bamboo (*Teinostachyum dullooa*) and *Gigantochloa andamanica* by planting part-clump.



Culm- or stem cuttings: Generally 1, or 2 noded cuttings of 1-3 years old culms are planted obliquely or horizontally. The upper parts and the lateral branches of the upper culm are discarded. The branches on each culm segments are generally pruned to the length of 10-30 cm and no foliage is retained. April is generally the best month for planting. Horizontal planting gives better result. Many species can be propagated easily in this way in places where humidity is high. Some of the species which are not easily propagated in this manner may be treated with rooting harmones and other chemicals like Indole acetic acid (IAA), Indole butyric acid (IBA), Naphthalene acetic (NAA), and Coumarin-Boric acid (CBA) for successful rooting. The cuttings from the basal portion of the culms give better results.



As some of the species like *Bambusa vulgaris, B. multiplex,* etc. root easily without any treatment this mode of propagation is commonly adopted for some species particularly in the Northeastern states and South Indian states (Karnataka). This mode of propagation is becoming increasingly popular for raising plants on a large scale. Most of the species may be rooted using rooting harmones/substances. Good success and survival (40-80%) have been obtained in *Bambusa balcooa, B. bambos, B. nutans, B. tulda, B. vulgaris, Dendrocalamus giganteus, D. hamiltonii, D. hookeri* and *D. lonispathus*.

Branch Cuttings: Branches from culm which are one and-a-half or two year old and disease free should be selected. Cut the branches along with rhizomatous swelling at their base and aerial root, with the help of a hacksaw. Make branch cuttings by trimming the leaves and small branches tips with secateurs. Each cutting should have 2-6 nodes with healthy buds, and should be 50-80 cm long. Place the cuttings in a hormonal solution viz. Idole Butyric Acid or IBM 200 ppm concentration for 24 hours, to facilitate root formation. After that seal the ends with wax. Before planting dip the cuttings in an appropriately diluted fungicidal solution, like Baviston (0.1%). Cutting should be kept vertically in raised beds, 2-3 cm apart, with the base at 7-10 cm depth and soil firmed up around the base by pressing. The planting bed should have soil, sand and FYM in the ratio of 1:1:1. Try to make arrangements for regular misting and shading. Sprouting take

place after 7-10 days, healthy root development occur between 30-60 days (from cutting taken in April-August) or 55-70 days (for cutting taken in October-November). Remove the cuttings from the bed and transplant them in polybags (15 x 23 cm) containing sandy loam and cow dung in the ratio of 3:1. Species that bear small branches at the top of culm, can not be propagated through this method. This method applies to the thick walled, sympodial bamboos. *Bambusa vulgaris* is easily propagated through branch cuttings.



Pre rooted and prerhizomed branch cuttings: These are branched having aerial roots and rhizomes at their swollen base when attached to the culm. Cuttings of these branches along with roots and rhizome should be taken for propagation. Use of saw is most suitable for the excision of branches from the culm. Aerial roots and rhizomes of such cuttings are not always fully active. If the collection site is nearer to the nursery the collected branches can be carried in bucket containing water. Maximum care should be taken to prevent drying the cut ends. The leaves, auxillary branches and tips of the collected branches are to be trimmed. A trimmed branch should be 50-80 cm long having 2-4 nodes with healthy buds. The final trimming should be done just before putting the branches into sand rooting medium. If these branches are directly planted in the field their survival rate is very low and the development is also stunted. So, to produce a well developed root system such cuttings should be placed in the sand media of propagation bed.

Layering: Layering is a method of bringing a culm or branch in contact with a rooting medium so that propagation occurs. There are four type of layering.

- Ground and simple layering
- Stump layering
- Air layering or marcotting
- Seedling layering

Ground layering: In this type of layering roots grow when a part of the culm is in direct

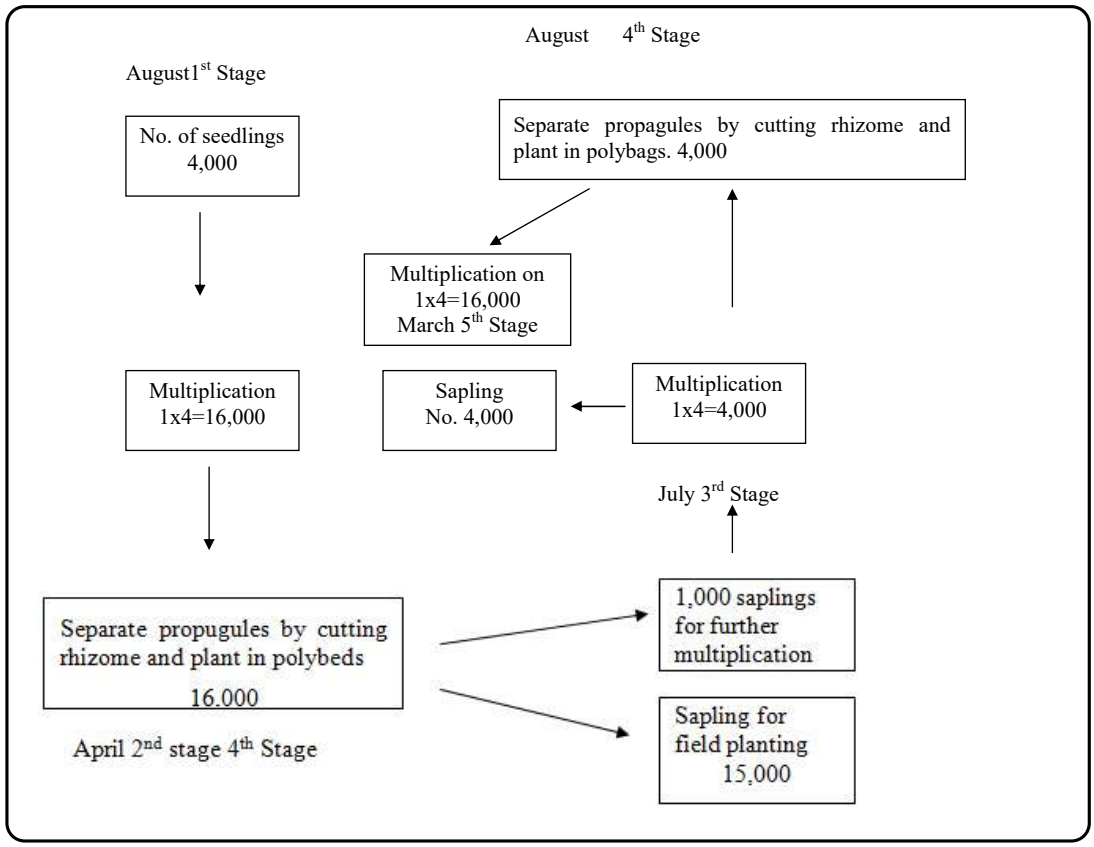
contact with the earth. Select a young (less than 2 years old) and healthy culm. Prepare a shallow trench (10-12 cm deep), long enough to hold a culm portion with 5-6 nodes. To stimulate the growth of buds at the nodes, cut off the top and tapering portion of the culm. Keep the branches and leaves on the upper nodes (at least 5-6 nodes) and lower 4-5 nodes of the culm intact. At the remaining nodes, trim the branches and leaves, including branchlets. Bend the culm down to the ground. If it is does not bend easily, make a partial cut near the base. Keep pressure on the culm and peg it down into shallow trench. Cover the portion of the culm in the trench with the rooting medium. Brushing and buried portion of the culm at the nodes with a rooting harmone will stimulate growth. Water regularly without waterlogging. Roots will develop at the nodes. When the roots are established, separate the rooted nodes along with a 7-10 cm portion of the culm on either side.

Stump layering: In the type the culm is cut leaving 2-3 basal nodes. The stump is treated with 200 ppm (20 grams dissolved in 100 litres water) IBA, and covered as well as tied with rooting medium of 1-2 cm thickness. Sprouts usually emerge after 150-180 days, and may be separated and planted.

Air layering or marcotting: Macrotting involves bending of one year old culm so that all the nodes come within easy reach of the worker. The branches of the nodes are pruned to about 2.5 to 4 cm from node in such a manner that the dormant buds are not damaged. An admixture of garden soil, leaf mulch and root, one or any other commercial rooting hormone preparation is placed around each node and longitudinally wraped with coconut fibre or water hyacinth root. This is then securely tied on both ends. Successfully rooted nodes are separated from the culm to become new plant of its own root system and transplanted in polybags and planted in the field.

Seedling layering: Seedlings aged 6-12 month are placed horizontally on the sand rooting medium, the culms are buried 1.5-20 cm but branches on the nodes are allowed to project above. Most seedlings at this stage have 3-4 culms each with 6-8 nodes. It is particularly successful for *Bambusa polymorpha*. Root develops at the nodes in 60-90 days. The rooted branches are separated by cuttings with secateurs and transplanting to polybags with soil and cowdung.

Macroproliferation: In macro proliferation method for multiplication of bamboo seedlings through rhizome separation, a 5-9 month old seedling of *Bambusa bambos, Bambusa tulda, Dendrocalamus hamiltonii, Dendrocalamus strictus, Teinostachyum dullooa* and *Thyrsostachys siamensis* can be multiplied 3-4 times in number through this technique. The base material (seedlings) are raised from seed. The macroproliferation method of vegetative propagation is universally applicable and can be used for mass production of field plantable saplings of sympodial bamboo. Each propagule seedlings possess the well developed shoot, root and rhizome parts at the time of tiller itself, which ensures rapid establishment and practically 100% survival of the propagative material. Each tiller along with a portion of rhizome are cut with the help of a sharp knife and planted in polybag.



Thus from one seedling app. 4 new seedlings can be prepared. Advantage of this method is that once seedlings of a bamboo species are available the process can be continued for number of years. But such seedling multiplication should not be continued for very long time. The detailed plan is mention below:

(iv) Layering

The whole culm with or without rhizome is buried lengthwise by the onset of monsoon. From the nodes young plants develop. This method is occasionally adopted in Northeastern region for planting village groves.

Seedling-multiplication: A bamboo seedling, at the age of 30-40 days, produces new culms (tillers) and starts developing rhizome; after 9 months it attains 4-5-miniature culm stage when each seedling may be separated into as many units with independent rhizomes, roots and shoots. In order to avoid/minimize casualties the seedlings after separation should be kept in shade, watered twice a day for 3 days and then brought to the nursery beds under the sun. In this fashion each seedling could be multiplied many folds and the process may thereafter be repeated over the years, once every six months and the propagules multiplied in increasing numbers. This mode of multiplication may be adopted when the availability of the seed is limited and inadequate for providing the

desired number of plants. Generally, in many species, during the period of gregarious flowering enough seeds will be available for large scale planting.



Seedlings germinated in Hiko tray

NURSERY AND PLANTATION

Nursery: Nursery beds of 10 m x 10 m, raised upto 20 cm from ground level are prepared before planting the material. Both edges of the beds are supported with pucca bricks or bamboo to prevent it from crumbling or washed away during heavy rains or irrigation. The soil of the bed up to the depth of about 12 cm is taken out before planting and kept in the sun for about 25 days for weathering. After weathering, the soil is mixed with well decomposed farmyard manure and sand thoroughly in 1:1:1 (soil: sand: FYM) ratio. The mixture is treated with 10% BHC to prevent termite attack and then the mixture is filled in the beds and properly leveled.

Classification of Nurseries: Nurseries are classified either on the basis of irrigational facility or the duration of their use. In case of bamboos both the nurseries are quite useful and are required. On the basis of irrigational facility nurseries are classified into:

- Dry nursery – It is a nursery that is maintained without any irrigation or other artificial watering.
- Wet nursery – It is a nursery that is maintained by irrigation or other artificial watering during the dry periods.

Temporary nursery – It is a nursery that is maintained for supplying nursery stock for a short period after which it is abandoned. It is also referred to as field nursery formed in or adjoining the planting area.

Permanent nursery – It is a nursery that is maintained for supplying nursery stock for a long time on a permanent basis. The duration of service life of permanent nursery is long and it is maintained till seedlings can be raised in it at reasonable cost.



Plants in Nursery

Selection of sites: Each site represents a distinct combination of inter-related environmental conditions produced by the topography of the land, the type, fertility and drainage of the soil, the amount and seasonal pattern of rainfall, the intensity of sunshine, air movements and many other more obscure but significant factors. The only way to ascertain the suitability of any bamboo to a given site is by actual trials. Until such local trials have been made, it will not be possible to predict the exact performance of a given species in a given site. However, with the available experience one can generalise that bamboos are expected to show vigorous growth under conditions of high soil fertility, good drainage and abundant rainfall well distributed throughout the year. In general sympodial or clump forming bamboos prefer almost year-round high temperatures; monopodial's prefer a cooler climate.

Sometimes wood quality (hardness and strength) is preferred over the large size of culms, this is relatively better achieved in poor soils and dry sites.

Selection of species: The diversity manifested by bamboos in respect to physical and silvicultural characteristics is of great importance to the users. One or a few kinds may prove best for one purpose under one set of conditions, and another may prove best for another purpose and another set of conditions.

In selecting bamboos for cultivation, primary consideration should be given to the products or purposes for which these are to be grown. It is important to realize that different bamboos vary widely in their thickness and physical properties of their wood, in size, shape, internode length, branching and other characteristics of their culms, in length and thickness of individual fibres (for paper pulp), aesthetic aspect of the plant,

soil binding capacity of the rhizome and root system, palatability of young shoots for food, etc. Moreover, as between two species that are more or less equally suited to a given purpose, one may thrive better than the other under a given set of ecological conditions. This can as earlier stated be determined only by actual field trials. For instance Muli bamboo (*Melocanna baccifera* and the giant bamboo (*Dendrocalamus giganteus*) are as good as or better than *Dendrocalamus strictus* for paper pulp, but their requirements of ecological conditions are much different from that of *Dendrocalamus strictus*. Similarly the temperate ornamental *Phyllostachys* spp., like black bamboo, would not thrive in hotter plains, and the tropical yellow bamboo (*Bambusa vulgaris* var. *vittata*) would not thrive in temperate Himalayas.

In our country the choice of species for cultivation with reference to various parameters is still confined mostly at local level viz., villagers by tradition and experience cultivate different species for different end uses which are suited to their areas. Such traditional practices are mainly confined to cultivation in homesteads and in village groves. In the above types of cultivation the purpose and ecological conditions are the main criteria, the planting material not being a constraint as only limited quantity is required. In large scale bamboo afforestation/plantation programme, till today, the major consideration has been availability of propagation material and the next is site conditions, because paper industry can consume almost all kinds of bamboos.

Planting: Pits of 30 cm cube are dug at 5 m x 5 m spacing. Dug-out soil is allowed to weather and then refilled. The spacing of pits may vary slightly according to the clump size of the species and also according to the moisture availability to the plantation. Offset planting can be started one to two months before the beginning of the rainy season provided watering is possible up to the start of the rainy season. Generally offsets, seedlings, culm cuttings, etc. are planted by the beginning of monsoon. After planting, three weedings are done in the first year and two in the second year. Causalities are replaced in the year of planting, and again at the beginning of next year monsoon. Soil working is done around the seedlings to a radius of 30 cm, and to a depth of 8 to 10 cm, along with the last weedings of the first year and the second year. The area is required to be strictly protected from grazing by providing fencing.

Fertilization: Bamboos are generally found on soils rich in organic matter, nitrogen, iron, manganese and potassium. Field trials have shown that the supply of nutrients considerably increased growth and biomass production. Significant increase in the biomass yield was obtained by the application of NPK. Suitable time for the application of NPK is about one month before the shoot emerge out from the ground. Fertilization of the plantation can increase the yield by more than 50%. In homestead cultivation for increasing the yield farmyard manure is applied annually in summer.

Protection: Bamboos need protection from domestic cattle and wild animals. Young plants, in seedling stage, suffer from depredation by rats, hares, porcupines, squirrels, pigs, deer- some of them gnaw the tender shoots while others eat up rhizomes. Wild angulates

and domestic cattle graze the seedlings and browze the young plants; also trample the seedlings. Porcupines and rats which burrow and gnaw the rhizomes damage the established clumps also. The monkey and elephants do the major damage. Grazing pressure and fire are the major causes for the decimation of bamboos by seriously affecting the regeneration in natual forests. Bamboo farming is profitable especially in private lands where protection cost is low.

Silvicultural tending: One of the major causes of the low productivity in the bamboo plantations in forest areas is the neglect or insufficient tending. Regular weeding, especially the removal of twiners/climbers, and before rainy season mounding/heaping soil each year around the clumps should be carried out. Silvicultural tending ameliorates productivity; Nepal Mill in Madhya Pradesh increased the productivity by ca 35% by continuous tending operation. The above example and the protection explains the reasons for the high productivity of bamboos in the homesteads and village groves.

Mixed plantation

Bamboo can also be grown mixed with other tree species e.g. Teak, Sissoo, Khair, Semul, *Eucalyptus* etc. Generally mixed plantations of Bamboo – Teak and Bamboo – Khair are common. The spacing adopted in mixed plantations varies from 6 m to 12 m between the bamboo clumps.

MANAGEMENT HARVESTING BAMBOO

Bamboo is harvested for:

- Bamboo shoot
- Bamboo culms

Shoot Harvesting: In this method only selected edible bamboos like *Chimonobambusa callosa, Dendrocalamus asper, D. hamiltonii, D. longispathus, D. strictus, D. giganteus, D. latiflorus, Melocanna baccifera*, *Bambusa bambos, B. nutans, Phyllostachys heterocycla* var. *pubescens, P. bambusoides,* etc. are considered. The shoots emergence in tropical and sub tropical bamboos generally start from the month of May and continue up to August. Other group like *Phyllostachys mannii* generally starts from February and continue till May. The shoots are harvested from the base when it attains a height of approximately 1 meter growth. The harvesting should be done randomly keeping some shoots to remain at mother clump for the next year culm.

Culm harvesting

Congestion in Bamboo Clumps: The bamboo has been managed generally under a four year felling cycle under an overlapping working circle and exploited through contractor's agency. In between the years of fellings, bamboo areas have been subjected to fellings by right-holders and concessionists and even more to illicit fellings by villagers. The thieves as well as the right-holders and concessionists never follow the bamboo cutting rules and even the contractors have always avoided to follow them where they found that such observance of rules would cost them more than the cost of the clumps that they would so obtain. The cumulative effect of careless fellings by thieves and right-holders and concessionists and tendency of forest contractors to avoid to follow the cutting rules has been the congestion in the bamboo clumps and it is not an uncommon sight in any bamboo forest to find as many as 90% of the clumps badly congested.



Cause of Congestion: The congestion can be ascribed to the following reasons:
Cutting of bamboos by villagers on the periphery of clumps: Villagers whether in exercise of their rights and concessions or by way of theft invariably fell the bamboos from the periphery of clumps only as it is easier to fell them. This practice stops the outward development of rhizomes and results in new culms coming out from the interior of the clump causing inter-mingling of culms which results in malformation and deterioration in quality and quantity of new bamboo growth.

Non observance of cutting rules by forest contractors: Forest contractors invariably avoid to follow the cuttings rules laid down for the purpose because it is often uneconomical for them to do so. Their labour is inclined to remove only such culms from the periphery of the clump as the contractor is entitled to removed under the rules. They never try to remove culms from the interior and the result is that even after the main felling, the clump is left more congested than before.

Grazing: As the bamboo is invariably worked under an overlapping working circle, its annual coups are generally very big and the cost being prohibitive, its fencing is never prescribed. Consequently the new culms that appear on the periphery of the clumps after the felling, are damaged by cattle and those which appear in the interior escape such

damage. This prevents the outward growth of the rhizomes and also causes branchiness in the remaining culms and the results is that even after the main felling, instead of having been cleared of congestion, a clump is left all the more congested.

BAMBOO FELLING RULES

The problem of regulating the felling of bamboo areas in relation to the rest of the forest crop is of vital issue. In most cases in the State, bamboos are being worked under overlapping working circles. The management of bamboo has generally been subordinated to fit in with the management of other species. This has inevitably resulted in the incidence of bamboos decreasing over large areas. It is also unfortunately true that while careful management plans have been prepared for Bamboo forest, the vast majority of bamboo harvested in the region is cut in a haphazard way by private agency (through contractors). It is, therefore necessary to remedy this evil.

At present, the prescriptions differ slightly from Division to Division. But in order to have an uniform set of rules for the whole State that will ensure a progressive improvement of the bamboo crop and eventually result in maximum sustained production the following rules are prescribed:

(i) The period of lease has generally been based on administrative convenience; proper consideration should also be given to optimum productivity and conservation.

(ii) Immature and undeveloped clumps, if any, even in mature bamboo coupes should not be worked but should be allowed to develop fully.

(iii) In well developed clumps capable of producing firm sized culms, felling should be carried out in a Thinning out principle.

(iv) No new shoots or 1 years old culms should be cut. A minimum number of mature culms (equal to the number of 1 years old shoots) should always be retained. If due to vagaries of nature, no new culm is produced in a particular year, at least half the number of culms in a clump should be retained. The idea is to cut only half the availability.

(v) The culms retained should be well distributed over the rhizome system so that the new or young shoots have sufficient support.

(vi) Cutting on the periphery should be avoided as far as possible, as it is not in accordance with the principle of thinning and further checks the outward growth of a clump.

(vii) Every endevour should be made to cut the culms as low as possible, just above the first node (30 cm above ground level).

(viii) The use of sharp instruments for cutting should be insisted on. The possibility of introducing thin-bladed saws for cutting should be considered.

(ix) Hacking and lopping of top ends for fodder by graziers, which is widely prevalent at present in out forests, should be prohibited.

(x) Culms and clumps in flower should be cut only after seedling has taken place.

(xi) Cutting of succulent shoots for cooking should be prohibited and discouraged.

(xii) Digging of culms with roots for sticks and picottahs should be kept down.

(xiii) No cutting of bamboos during rains should be allowed in order to avoid damage to young shoot.

(xiv) Culms should not be cut during full moon.

(xv) Debris resulting from cutting should be heaped away from the clumps.

HISTORY OF BAMBOO TAXONOMY

The plate (number 16) in Hortus Malabaricus bamboo known in the local Malayalam as "*Illy*", is possibly the first published illustration of a bamboo of scientific value. Though the illustration in Hortus Malabaricus is poor "*Illy*", which identifies the plant used to this day for the common thorny bamboo of southern India. Jan Commelin, one of the scientific collaborators in producing Rheede's Hortus Malabaricus called it "*Arundo arbor*", citing Avicenna Bauhin's Pinax (which was later named as *Bambusa arundinacea*). At the time when Commelin was preparing the comments on the bamboos for the text, he had the drawing of the bamboo from the Malabar coast, which included flowering branches. He also received some specimens which had been collected in Ceylon (Sri Lanka) by Paul Hermann, Dutch botanist between 1670-1677. If plants of the Malabar coast and Ceylon flowered at the same time, Hermann and Rheede must have seen them between 1674 and April of 1675. At the top of page 25 in Hortus Malabaricus Commelin comments that this plant flowers every 60 years and dies, possibly it is the first reference of flowering cycle mentioned in any bamboo.

Carolus Linnaeus, a young Swedish physician and botanist visited Holland in 1735, where he spent at de Hartecamp (George Clifford's large estate). Clifford hired him as personal physician with duties to catalogue the plants in the estate, acquire new ones and publish manuscripts on these. In 1737 appeared the results of Linnaeus's efforts in the form of book, Hortus Cliffortianus. Linnaeus listed here an "*Arundo arbor*" showed that Clifford had a bamboo in cultivation at his estate at that time.

The first bamboo classification formulated by Rumpf (1750) who divided bamboos under 8 classes all with the name *Arundo*. Soon after Linnaeus (1753) used the classification with little change in the nomenclature of one species under the name *Arundo bambos*.

Another bamboo was described as *Arundo gigantea,* the "large cane" of southern United States, which was published in Walter's Flora that what had been called *Arundo bambos* represented a distinct genus from *Arundo*. Retzius called it *Bambos* employing the specific new genus from, *Bambusa*. The latter name has since been accepted. The

herbarium thorny bamboo and a non-thorny bamboo, and chose "*arundinacea*" as the specific name and described this species on the basis of the two different bamboos which he had mounted on one sheet. The sheet with these two plants was deposited in the Lund Herbarium. In recent years, the non thorny material has been identified as *Bambusa vulgaris*.

In 1790, another well known bamboo was described, this one by Joan de Loureiro, a Portuguese missionary and naturalist. The bamboo was called *Arundo multiplex* (later recognized as a species of *Bambusa*). In 1791 *Nastus borbonicus* was described by Gmelin from the Island of Reunion, and in 1803 Andre Michaux transferred *Arundo gigantean* to the genus *Arundinaria*. Therefore during that time, only three earliest described genera of bamboo *Bambusa, Arundinaria* and *Nastus* were known.

In the early 1800's, the East India Company was flourishing, and headquarter of the enterprise had been established at Calcutta. Across the Hoogly river was the Company's Garden, of which Dr. William Roxburgh was the Director. Roxburgh (1814) listed seven species which were later described in "Flora Indica" (1832) and the number of genera and species of bamboos was increasing at a rapid speed. Kunth recognized bamboos as one of his ten natural groups of genera. He referred to the group as "Gramina Bambusacea". Nees von Esenbeck in 1835 published a book on the bamboos of Brazil (Bambuseae Brasilienses) in which he included *Streptochaeta* as one of the bamboo group and was thus the first to establish relationship between woody and herbaceous species. In his treatment of Bambuseae, he recognized 2 sub-genera, *Bambusa* and *Guadua*.

The first comprehensive work on bamboo taxonomy is that of Franz Joseph Ruprecht (1839). He recognized 67 species under nine genera in which 18 species were described from Indo-Malayan region. The next monograph of bamboos to appear was that of Colonel William Munro. Since this world monograph published in 1868, there has been none other, and it remains a classic to this day, one of the most useful original references on bamboos. Munro had joined English army at the age of 16, eventually raising to the rank of General in the 39th Regiment. His monograph contains beautifully written introduction, excellent description, notes and classification which provided a foundation of the modern knowledge of bamboos. He described 21 genera and about 170 species, out of which 70 belonged to Indo-Malayan region.

After Munro, a young German, Wilhelm Sulpiz Kurz, Curator of the herbarium in Calcutta, who later went to Indonesia where he learned about bamboos, wrote an excellent paper on "Bamboos and its uses", which appeared in 1876. It is full of original information. He was the first to make observations on the special nature of the proliferating bamboo spikelets, later called "pseudospikelet" by McClure (1934), also described 30 species from Myanmar. Kurz's plan to write an account of the bamboos of India ended with his premature death at Malaysia in December 1877. His notes and specimens, however, were later on used by Gamble. Andrien Franchet (1877), a botanist from Paris, wrote a small article with description of 4 new genera of herbaceous bamboos from French Congo and

a woody *Glaziophyton* from Brazil. Beddome (1880) described 18 indigenous species from South India. Bentham (1883) modified the system of classification given by Munro in which 14 genera out of 22 belonged to Indo-Malayan region and the rest being chiefly American.

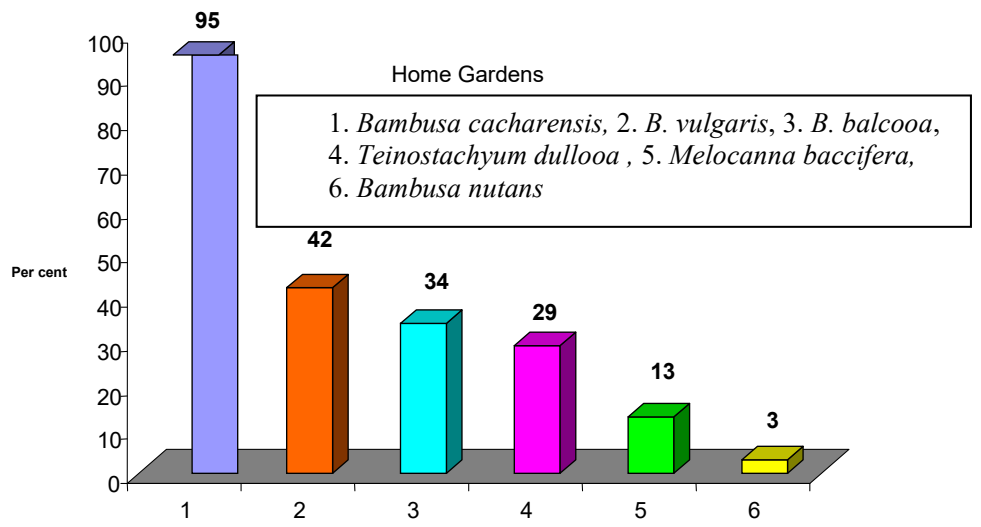
Sir Dietrich Brandis from Germany was called upon by the British Scientists to help them in the forestry matters, in which Germans had much more experience. Brandis was in Myanmar between 1856 and 1862. He did not work principally on bamboos but he published a remarkable paper in 1907 on the structure of bamboo leaves and noted the great similarity in features of the leaf anatomy and epidermis of different bamboos.

James Sykes Gamble in 1890 was appointed Director of the Imperial Forest School at Dehra Dun where he remained till 1899. Gamble (1896) produced a monumental monograph, which included 15 genera covering 115 species and contained 119 plates of bamboos from India, Myanmar and Malaya. He traveled much in India and recognized the importance of vegetative characters in identifying bamboos. His system of classification was adopted from Bentham's system and included one additional genus i.e. *Thyrsostachys* which was described by him. This publication was certainly the most exhaustive work of its time.

By the beginning of this century, the study of bamboos had progressed rapidly with major emphasis on those of India. No further world monographs on bamboos have appeared in this century except that of E.G. Camus (1913) in French mostly a compilation of all previous works. But it was poorly prepared and cannot be relied upon (Soderstrom, 1985). Thus after Gamble's work there has not been any effort in the field of taxonomic studies on Indian bamboos.

As regards the status of the bamboos of World there is disparity regarding the number of genera and species. Vermah and Bahadur (1980) mentioned nearly 1000 species. Ohrnberger and Goerrings (1985) estimated 130-160 herbaceous bamboos under 25 genera, the woody bamboos comprise of 85 genera and 880-980 species. Biswas (1988) estimated 1200 species under 70 genera. However, the report of Clayton and Reinvoize (1986) is probably more authentic who reported ± 840 species under 49 genera. In context of India, Gamble (1896) reported 115 species from Indian subcontinent, of which 63 species under 13 genera were mentioned from present India. There are many reports regarding number of genera and species of India viz. Tewari (1993) stated 125 species under 23 genera. According to Seethalakshmi and Muktesh Kumar (1998), 128 species under 18 genera are known from India. According to a report by INBAR (2005), India is represented by 145 species belonging to 23 genera. Naithani (2008) reported 113 species under 20 genera from India. After 2008 many new species and new records have been published. In a assessment of Indian bamboos by Sharma and Nirmala (2015) revealed 148 species under 29 genera. In recent past three new genera viz *Kuruna, Munrochloa* and *Stapletonia* were described from India and Sri Lanka.

In view of the absence of flower in most herbaria, localized distribution of species and high morphological variations, the same bamboo species are often named differently by different workers, working in different parts of the world, creating taxonomic ambiguity. Every taxonomist would have their own view and disagree upon which groups to give a separate generic name to and which to merge. Unfortunately, most references relating to bamboo taxonomy are contradictory to each other and express divergent views on several species making it difficult for establishing a firm taxonomic identity. (Barik *et al.* 2009). For example, genus *Cephalostachyum, Neohouzeaua, Pseudostachyum, Teinostachyum* have been merged under a single genus ***Schizostachyum***. These are now split into their original status. Genus ***Arundinaria*** is split into many genera viz. *Ampelocalamus, Borinda, Chimonobambusa, Chimonocalamus, Drepanostachyum, Fargesia, Himalayacalamus, Indocalamus, Kuruna, Microcalamus, Neomicrocalamus, Pleiobastus, Sarocalamus, Sinoarundinaria, Thamnocalamus* and *Yushania*. ***Oxytenanthera*** is a monotypic genus native of Africa, its all Indian species have been transferred either to ***Gigantochloa*** or ***Pseudoxytenanthera,*** Genus ***Melocalamus*** has been merged under *Dinochloa*. However, recent studies shows that these two are distinct genera, ***Dinochloa*** is confined only in Andaman & Nicobar Islands, India. Recently *Cephalostachyum, Pseudostachyum* and *Teinostachyum* (*Neohouzeaua*) now been treated as independent genera. Another example i.e. Gamble 1896 & 1906 (in Brandis Indian Trees) treated *Bambusa tulda, B.nutans* and *B.teres* and *B.longspiculata.* However, Majumdar (1989) has merged *B.longispiculata, B.nutans* and *B.teres* under *B.tulda.* Similar taxonomic controversies are observed in case of *Phyllostachys mannii,* which has always been confused with *P.assamica* and *P.bambu-*



Source: **Das & Das (2005)**

soides. The inclusion of *Phyllostachys mannii* in the IUCN Red List is difficult to justify given its broad distribution range, after merging all the species complex together (Chao and Renvoize, 1989). Number of species under each genus in World, India and North-east India mentioned in (Table 35).

Table: 35- Number of species under each genus in World, India and North-east India

Genera	Species in World	Species in India	Species in Northeast India
Ampelocalamus	13	1	1
Arundinaria	08	2	2
Bambusa	120	20	20
Cephalostachyum	10	8	8
Chimonobambusa	37	3	3
Chimonocalamus	11	4	4
Dendrocalamus	40	10	10
Dinochloa	25	2	X
Drepanostachyum	10	4	4
Gigantochloa	15	2	2
Melocalamus	05	4	4
Melocanna	03	2	2
Munrochloa	1	1	X
Neololeba	5	1	X
Neomicrocalamus	05	02	02
Ochlandra	12	11	X
Phyllostachys	50	4	4
Pleiblastus	40	1	1
Pseudosasa	19	1	1
Pseudoxytenanthera	5	4	X
Pseudostachyum	1	1	1
Schizostachyum	50	1	X
Stapletonia	2	2	2
Teinostachyum (*Neohouzeaua)*	6	4	3
Thamnocalamus	5	4	4
Thyrsostachys	2	2	2
Yushania	80	11	7

Bamboos of adjacent countries i.e. Nepal and Bhutan have been dealt with by (Stapleton 1994b and 1994c), Bangladesh (Banik, 2000 and Alam, 2001), Sri Lanka (Soderstrom and Ellis, 1988), Myanmar (Htun, 2000).

NORTH-EAST INDIA

North-eastern region of India comprises the states of Arunachal Pradesh, Assam, Nagaland, Mizoram, Manipur, Meghalaya, Tripura and Sikkim. The region covers a geographical area of approximately 2,62,179 km^2. The region has about 14% of the country's forest under control of Forest Department. Arunachal Pradesh and Sikkim have the highest mountains with altitude varying from 1200-7300 m. The status of Bamboos of North east India have been worked out from time to time i.e. Bor (1940); Trivedi and Tripathi (1984); Naithani (1987 & 2006a); Biswas (1988); Shukla (1996); Hore (1998); Sharma *et al.,* (1992). State wise the distribution of the species have been stated by Haridsasan *et al.,* (1987)- Arunachal Pradesh; Barooh and Borthakur (2003)- Assam; Khalyngdoh and Barik (2007), Naithani, (2007a & 2007b), Bhaumik and Hynniewta (2007), P.Kumari and P. Singh (2014)-Meghalaya; Bisht and Naithani (2010)- Mizoram; Deb (1961), Naithani *et al* (2010)-Manipur; Naithani (2011)- Nagaland; Deb (1983), Banik (2006), Sasikumar *et al.* (2015)- Tripura; Stapleton (2000), Sharma and Borthakur (2007)-Sikkim and Mitra and Mukherjee (2007)-West Bengal.

In India, contribution of clump forming bamboo is approximately 67.3%. Of the total growing stock of bamboos contribution of *Dendrocalamus strictus* is 45%, *Bambusa bambos* (*B. arundinacea*)-13%, *Dendrocalamus hamiltonii* -7%, *Bambusa tulda*- 5% and *Bambusa pallida* or *Bambusa jaintiana* is approx. 4%. All other species put together contribute approx. 6% of the total growing stock. However, Adkoli (1994) estimated that 83% of total growing stock comprised mainly from *Dendrocalamus strictus* 53%, *Bambusa bambos* 15% and *Melocanna baccifera* 15%.

Out of 32.7% growing stock of non clump forming bamboo, *Melocanna baccifera* found in North-east India accounts for 20% growing stock. Its share in the total growing stock of bamboos in Assam is (40%), Manipur-94%, Meghalaya-46%, Mizoram-93% and Tripura is 92%. *Dendrocalamus hamiltonii* is also widely present in Arunachal Pradesh (29%), Assam (60%), Nagaland (54%). As far as *Bambusa tulda* is concerned, it is distributed in Arunchal Pradesh (32%), Nagaland (25%), while *Bambusa pallida* is 37% in Arunachal Pradesh and 13% in Nagaland.

Table -36: State wise Distribution of Bamboo area in Recorded Forest Area

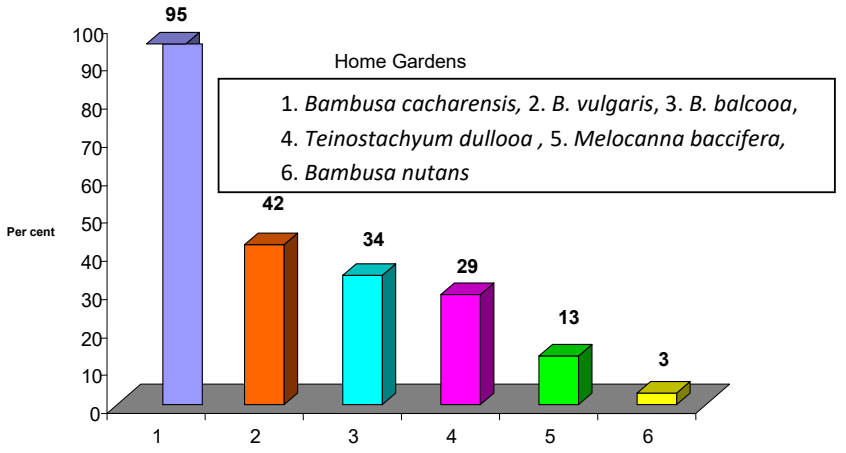
State/UT	Bamboo bearing area (sq km)	Bamboo bearing area (sq km)as per ISFR 2011	Change in area with respect to ISFR 2011
Arunachal Pradesh	15,125	16,083	-958
Assam	8,955	7,238	1,717
Manipur	10,687	9,303	1384
Meghalaya	5,943	4,793	1150
Mizoram	3,267	9,245	-5,978
Nagaland	6,025	4,902	1123
Sikkim	553	1,181	-628
Tripura	3,617	3,246	371

Source: FSI (2017)

FARM BAMBOO

The term "Farm bamboo' is generally used as a common word to indicate all bamboo originating from areas other than Govt. Forests. It includes bamboos grown by farmers in plantation on field-bunds, in back yards and homesteads or bamboos growing on common lands, river banks, canal banks etc. Farm bamboo adds substantially to farmers income. In Assam, it accounts for 30% of total bamboo production in the state. Reports from Assam indicate that farm bamboo is being supplied to paper mills even outside the state (Anon. 1999). Generally, *Bambusa nutans, Bambusa tulda, Bambusa balcooa, Bambusa vulgaris, Bambusa bambos, Dendrocalamus strictus* and *Pseudoxytenanthera stocksii* (*Oxytenanthera stocksii, Dendrocalamus stocksii*) are preferred by farmers. In Kerala for instance, the reed bamboo *Ochlandra* spp., found in the forest, while other bamboos are cultivated in 'home gardens'. Das and Das (2005) while invenstorising diversity of different plant species in Barak Valley, Assam found the presence of bamboo in all home gardens. Based on their utility and preferences, farmers have prioritized *Bambusa cacharensis* which have multiple local uses, followed by *Bambusa vulgaris* and *Bambusa balcooa* which is a also common in the Jaintia Hills (Meghalaya) area bordering Bangladesh and Jiribam areas of Manipur.

Fig-: 9: Distribution of Village Bamboos in Home Gardens



Source: **Das & Das (2005)**

Table-37: Distribution of Bamboo species in North-east India.

S.N	Name of species	A.P	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Tripura	Sikkim
1	*Amplelocalamus patellaris* (Gamble) Stapleton (*Dendrocalamus patellaris* Gamble, *Chimonobambusa jainiana* Das & Pal)	*	*				*		*
2	*Arundinaria febri* Rendle	*							
3	*Arundinaria racemosa* Munro (*Sarcocalamus racemosus* (Munro) Stapleton	*							*
4	*Bambusa alemtemshii* Naithani						*		
5	*Bambusa balcooa* Roxb.	*	*	*	*	*	*	*	
6	*Bambusa bambos* (L.) Voss. *(B.arundinacea* (Retz.) Willd.)	*	*		*	*	*	*	

7	*Bambusa barpatharica* Borthakur & Barooah		*						
8	*Bambusa burmanica* Gamble		?						
9	*Bambusa cacharensis* Majumdar		*	*	*			*	
10	*Bambusa comillensis* Alam							*	
11	*Bambusa dampeana* Naithani,S.S. Garbyal & N.S.Bisht					*			
12	*Bambusa garuchokua* Barooh & Borthakur	*	*						
13	*Bambusa griffithiana* Munro			?					
14	❖ *Bambusa guadua* Humb.& Bonpl.						*		
15	*Bambusa jaintiana* Majumdar *(B.assamica* Barooah & Borthakur)	*	*	*	*		*	*	*
16	*Bambusa khasiana* Munro				+				
17	*Bambusa manipureana* Naithani & Bisht			*					
18	*Bambusa majumdarii* P. Kumari & P.Singh				*				
19	*Bambusa mizorameana* Naithani			*		*			
20	*Bambusa mohanramii* P.Kumari & P. Singh				*				
21	*Bambusa mokokchun-geana* Naithani						*		
22	*Bambusa mompaena* Naithani	*							
23	❖ *Bambusa multiplex* (Lour.) Raeusch. ex J.A. & J.H. Schults.	*	*	*	*		*	*	

24	❖ *Bambusa multiplex* var. *rivereorum* R. Mairs				*	*			
25	*Bambusa nagalandeana* Naithani					*	*		
26	*Bambusa nutans* Wall. ex Munro (*Bambusa nairiana* P. Kumari & P.Singh)	*	*	*	*	*	*	*	*
27	*Bambusa pallida* Munro	*	*				*	*	*
28	❖ *Bambusa polymorpha* Munro	*	*		*			*	
29	*Bambusa pseudopallida* Majumdar		*		*				
30	*Bambusa rangaensis* Borthakur & Barooah		*				*		
31	❖ *Bambusa salarkhanii* Alam							*	
32	*Bambusa tulda* Roxb.	*	*	*	*	*	*	*	*
33	*Bambusa vulgaris* Schrad. ex Wendl.	*	*	*	*	*	*	*	*
34	*Bambusa vulgaris* var. *vittata* A. C. Riviere	*	*	*	*	*	*	*	
35	*Bambusa vulgaris* f. wamin Wen			*	*			*	
36	*Cephalostachyum capitatum* Munro *(Schizstachyum capitatum* (Munro) Majumdar, *S.munroi* Kumar & P.Singh)	*		*	*	*	*		*
37	*Cephalostachyum fuchsianum* Gamble *(Schizostachyum fushsianum* (Gamble) Majumdar	*	*	*		*	*		*

38	*Cephalostachyum latifolium* Munro (*Schizostachyum latifolium* (Munro) Majumdar)	*		*					*
39	*Cephalostachyum longwanum* Naithani						*		
40	*Cephalostachyum mannii* (Gamble) Stapleton & Li *(Neomicrocalamus mannii* (Gamble) Majumdar)	*		*	*	*	*		
41	*Cephalostachyum mishmianum* Naithani	*							
42	*Cephalostachyum pallidum* Munro *(Schizostachyum pallidum* (Munro) Majumdar)	*		*	?	*			
43	*Cephalostachyum pergracile* Munro *(Schizostachyum pergracile* (Munro) Majumdar)	*	*	*		*			
44	*Chimonobambusa callosa* (Munro) Makino *(C. arunachalensis* Sharma & Borthakur, *C. jainii* Sharma & Borthakur)	*	*	*	*	?	*		
45	*Chimonobambusa nagalandeana* (Naithani) Naithani						*		
46	❖ *Chimonobambusa quadrangularis* (France) Makino				*				
47	*Chimonocalamus griffithianus* (Munro) Xue & Yi *(Arundinaria griffithiana* Munro)	*		*	*	*	*		
48	*Chimonocalamus longispiculatus* Majumdar (*Siarundinaria arunachalensis* Naithani)	*							

49	*Chimonocalamus longiusculus* Hsuch & Yi	*							
50	*Chimonocalamus lushaiensis* Ohrnberge (*Sinarundinaria longispiculata* (Bor) Chao & Renv.					*			
51	❖ *Dendrocalamus asper* (Schult.f.) Backer ex Heyne	*				*	*	*	
52	❖ *Dendrocalamus giganteus* Munro	*	*		*	*		*	*
53	*Dendrocalamus hamiltonii* Nees & Arn. ex Munro	*	*	*	*	*	*	*	*
54	*Dendrocalamus hookeri* Munro	*	*	*	*	*	*		*
55	*Dendroalamus latiflorus* Munro			*		*	*		
56	*Dendrocalamus longispathus* (Kurz) Kurz		*	*	*	*		*	
57	*Dendrocalamus manipureanus* Naithani & Bisht			*		*			
58	*Dendrocalamus sahnii* Naithani & Bahadur	*			*				
59	*Dendrocalamus sikkimensis* Gamble	*	*	*	*	*	*		*
60	❖ *Dendrocalamus strictus* (Roxb.) Nees	*	*		*	*	*	*	*
61	*Drepanostachyum falcatum* (Nees) Keng, f.	*		*	*	*			
62	*Drepanostachyum hookerianum* (Munro) Keng, f.	*		*					*
63	*Drepanostachyum intermedium* (Munro) Keng,f.	*							*
64	*Drepanostachyum polystachyum* (Kurz ex Gamble) Majumdar								*

65	*Gigantochloa andamanica* (Kurz) Kurz		*	*	*			*	
66	*Gigantochloa albociliata* (Munro) Kurz				*				
67	*Melocalamus compactiflorus* (Kurz) Benth. & Hook.f.		*	*	*	*		*	
68	*Melocalamus graciles* Majumdar		*						
69	*Melocalamus indicus* Majumdar		*	*					
70	❖ *Melocalamus macellandi* (Munro) Naithani				*				
71	*Melocanna arundina* Parkinson		*						
72	*Melocanna baccifera* (Roxb.) Kurz	*	*	*	*	*	*	*	*
73	*Melocanna clarkei* (Gamble ex Brandis) P.Kumari & P.Singh)			*	*	*			
74	*Neomicrocalamus andropogonifolius* (Griff.) Stapleton						*		*
75	*Neomicocalamus prainii* (Gamble) Keng f. & Wen	*		*	*		*		
76	❖ *Phyllostachys aurea* Carr. ex River	*							
77	❖ *Phyllostachys edulis* (Carr.) Houzeau	*				*			
78	*Phyllostachys mannii* Gamble (*P.assamica* Gamble ex Brandis)	*	*	*	*	*	*		*
79	❖ *Phyllostachys nigra* (Lodd. ex Lindl.) Munro				*				
80	❖ *Pleioblastus viride-striatus* (Regd) Makino				*				

81	❖ *Pseudosasa japonica* (Sieb. & Zucc. ex Steud.) Makino ex Nakai	*			*				*
82	*Pseudostachyum polymorphum* Munro *(Schizostachyum polymorphum* (Munro) Majumdar)	*	*	*	*	*	*	*	*
83	*Stapletonia arunachalensis* (Naithani) P. Singh, Dash & P.Kumari *(Schizostachyum arunachalensis* Naithani)	*							
84	*Stapletonia seshagirianum* (Majumdar) Naithani *(Schizostachyum seshagirianum* Majumdar)	*							
85	*Teinostachyum dullooa* Gamble *(Schizostachyum dullooa* (Gamble) Majumdar, *Neohouzaeua dullooa* (Gamble) Camus)		*	*	*	*	*	*	*
86	*Teinostachyum griffithii* Munro *(Schizostachyum griffithii* (Munro) Majumdar)		*		?				
87	*Teinostachyum helferi* (Munro) Gamble (*Bambusa mastersii* Munro)	*			*				
88	*Thamnocalamus aristatus* (Gamble) Camus	*							*
89	*Thamnocalamus arunachalensis* Naithani	*							
90	*Thamnocalamus falconeri* Hook.f. & Munro *(Arundinaria falconeri* (Hook.f. & Munro) Benth. & Hook.f.)								*

91	*Thamnocalamus spathiflorus* (Trin.) Munro	*							*
92	❖ *Thyrsostachys oliveri* Gamble	*	*	*		*		*	
93	❖ *Thyrsostachys regia* (Munro) Bennet	*							
94	*Yushania elegans* (Kurz) Majumdar			*			*		
95	*Yushania hirsuta* (Munro) Majumdar				*				*
96	*Yushania maling* (Gamble) Majumdar	*							*
97	*Yushania pantllingii* (Gamble) Majumdar	*							*
98	*Yushania rollana* (Gamble) Yi	*		*			*		
99	*Yushania yadongensis* Yi								*
	Total number of species 99	**54**	**36**	**39**	**43**	**35**	**36**	**25**	**31**

❖ = Introduced, A.P. = Arunachal Pradesh + Imperfectly known species

HISTORY OF BAMBOO SYSTEMATICS IN MEGHALAYA

Gamble (1896) in his monumental work "Bambuseae of British India" recorded 27 species of bamboos from Khasi, Jaintia and Garo Hills, now Meghalaya. Bor (1940) while working on the grasses of Assam has reported only 17 species from Meghalaya. In the year 1985, HB Naithani & TTC Marak made bamboo survey in Meghalaya and reported 31 species. Majumdar (1989) has described three new species of bamboos from Meghalaya i.e. *Bambusa jaintiana, Bambusa pseudopallida* and *Schizostachyum mannii*. Shukla who has done extensive collection of grasses from Meghalaya reported 33 species in his publication (1996) "Grasses of North-Eastern India".

P. Kumari and P.Singh in their publication "Bamboos of Meghalaya" (2014) stated that "Apart from the studies on bamboos of North-east India only few taxonomic and floristic studies from Meghalaya are worth mentioning". References viz. Joseph (1982); Balakrishnan (1983) and Haridasan (1985) quoted by them are the floras in which no complete species of bamboos of Meghalaya were included. However, particularly only of bamboos of Meghalaya many articles were published, which were completely ignored by them. These articles are: Diversity of Bamboo species in Northeast India (Naithani 2006a). Status of Bamboo identification cum distribution (Bhaumik and Hynniewta (2007); Survey Report on the Distribution of Bamboo species in Meghalaya (Naithani, 2007 a); Bamboos of Northeast India with special reference to Meghalaya (Naithani, 2007 b); Diversity of Indian Bamboo with special reference to Northeast India (Naithani, 2008); Barik *et al.,* (2009) Taxonomic indentity…… *Sinarundinaria griffithiana* Chao & Renv. Diversity, distribution pattern and uses of bamboos in Meghalaya (Kharlyngdoh and Barik, 2007 & 2008); Status and strategies for conservation of bamboos resources of Meghalaya (Tiwari *et al.,* 2008); Bamboo Diversity of North-East India (Naithani, 2010). This indicate that before the publication of P. Kumari and P.Singh (2014) lot of the work on bamboos of Meghalaya have been done.

The present account of bamboos of Meghalaya is based on the field survey of species in 1985, 2007-2008, 2013 and 2014 from (total 43) all the districts of state. The work provided 40 species 2 varieties and a forma of bamboos under 16 genera both native and cultivated. There are 10 species which could not be located during survey have been excluded from the account. However, they are represented by old herbarium specimens. Regarding bamboos of Meghalaya. P. Kumari and P. Singh (2014) claims that their book does not to be the last word in the taxonomy of bamboos of Meghalaya. Certain gaps in the information still remains to be filled.

BAMBOO SURVEY TEAM





Table:38. Distribution of Bamboo species in Meghalaya

S.N	Botanical name	Local name	E.Khasi	W.Khasi	E.Jaintia	W.Jaintia	Mawkyrawt	E.Garo hills	W.Garo	N.Garo hills	S.W.Garo	S. Garo	Ri-Bhoi
1.	*Bambusa balcooa* Roxb.	Borua (G)	*		*				*			*	
2	*Bambusa bambos* (L.) Voss. *(B.arundinacea* (Retz.) Willd.)	Wakenta (G)						*	*		*		
3	*Bambusa cacharensis* Majumdar	Ba (J)			*	*							
4	*Bambusa jaintiana* Majumdar	Usken, Skhem (K), Uskhen, Skhen pnar, Thengrang-rai, Thning (J), Wathi-bok, Wathesa, Kolongki (G)	*	*	*	*	*	*	*		*		*
5	*Bambusa majumdarii* P.Kumari & P.Singh								*				
6	*Bambusa mohanrami* P.Kumari & P.Singh				*								

7	❖ *Bambusa multiplex* (Lour.) Raeusch. ex J.A. & J.H. Schults.		*										
8	❖ *Bambusa multiplex* var. *riv-ereorum* R. Mairs		*										
9	*Bambusa nutans* Wall. ex Munro		*		*			*	*				
10	*Bambusa polymorpha* Munro												*
11	*Bambusa pseudopallida* Majumdar	Wamemang				*						*	*
12	*Bambusa tulda* Roxb.	Seringjai (K), Themgrangai (J); Wati, Wagi (G)	*	*	*	*	*	*	*	*	*	*	*
13	❖ *Bambusa vulgaris* Schrad. ex Wendl.	Baruba, Natshi-lot (J), Waman-na (G)	*		*	*			*			*	
14	❖ *Bambusa vulgaris* var. *vitta-ta* A. C. Riviere		*										
15	❖ *Bambusa vulgaris* f. *wamin* Wen												*
16	*Cepha-lostachyum capitatum* Munro		*			*							

17	*Cephalostachyum mannii* (Gamble) Stapleton & Li (*Neomicrocalamus mannii* (Gamble) Majumdar					*							
18	*Chimonobambusa callosa* (Munro) Makino	U-spar, Spar (K)	*	*									
19	❖ *Chimonobambusa quadrangularis* (France) Makino		*										
20	*Chimonocalamus griffithianus* (Munro) Xue & Yi		*	*		*			*				
21	❖ *Dendrocalamus giganteus* Munro												*
22	*Dendrocalamus hamiltonii* Nees & Arn. ex Munro	Siejlieh (K); Syrtieh (J); Wanok (G)	*	*	*	*	*	*	*	*	*	*	*
23	*Dendrocalamus hookeri* Munro	Siejiong (K)	*	*		*	*						
24	*Dendrocalamus longispathus* (Kurz) Kurz				*			*					

25	*Dendrocalamus sahnii* Naithani	Tawang (K)	*										
26	*Dendrocalamus sikkimensis* Gamble	Wadah (G)						*	*			*	
27	❖ *Dendrocalamus strictus* (Roxb.) Nees		*		*								*
28	*Drepanostachyum falcatum* (Nees) Keng,f. (*D.khasianum* (Munro) Keng, f., *D.suberectum* (Munro) Majumdar)		*	*		*	*						
29	*Gigantochloa albociliata* (Munro) Kurz									*			*
30	*Gigantochloa andamanica* (Kurz) Kurz	Wasut (G)							*				
31	*Melocalamus compactiflorus* (Kurz) Benth. & Hook.f.	-			*								

32	❖ *Melocalamus macellandi* (Munro) Naithani	-											*
33	*Melocanna baccifera* (Roxb.) Kurz	Tyrlaw, Siejla (K); Rthem (J); Watrai (G)	*	*				*	*			*	*
34	*Melocanna clarkei* (Gamble ex Brandis) P.Kumari & P.Singh	Serim (J), Tyrpit (J)	*		*	*							
35	*Neomicocalamus prainii* (Gamble) Keng f. & Wen	Spit (K); Tyrpit (J)	*			*							
36	❖ *Phyllostachys mannii* Gamble	Siej Naga	*	*	*								
37	❖ *Phyllostachys nigra* (Lodd. ex Lindl.) Munro	-	*										
38	*Pleioblastus viride-striatus* (Regel.) Makino		*										
39	❖ *Pseudosasa japonica* (Sieb. & Zucc. ex Steud.) Makino ex Nakai		*										

40	*Pseudo-stachyum polymor-phum* Munro		*			*		*				*	*
41	*Teinos-tachyum dullooa* Gamble (*Neohou-zeaua dullooa* (Gamble) Camus)		*		*			*				*	
42	*Teinos-tachyum helferi* (Mun-ro) Gamble (*Bambusa mastersii* Munro)		*		*	*		*				*	
43	*Yushania hir-suta* (Munro) Majumdar		*	*									
	Total 43		**27**	**10**	**15**	**15**	**05**	**11**	**13**	**03**	**04**	**10**	**11**

❖ = Introduced, E= East, W.=West, N=North, S= South

Detail of Bamboo species in Meghalaya

BAMBUSA Schreb.

(From *bambos* or *bamboo*, a latinised vernacular name).

Bambusa balcooa Roxb.

Bambusa balcooa Roxb. (Hort. Beng. 25. 1814. *nom. nud.*) Fl. Ind. 2:196. 1832. *Dendrocalamus balcooa* (Roxb.) Voigt, Hort. Suburb. Cal. 718. 1845. *Bambusa capensis* Ruprecht, Bamb. 54. tab. XIII, fig. 54. 1839. *Bambusa vasaria* Ham. in Wall. Cat. 5025. 1828. *nom. nud.*
Local Name : *Borua, Gorua* (Garo)

Where to see it in Meghalaya: It is found only under cultivation. **East Khasi Hills:** Mawdon. **East Jaintia Hills:** Umkiang. **East Garo Hills:** Jengal. **West Garo Hills:** Ampati, Garobada, Rangram. **South Garo Hills:** Chambalgiri, Barengapara



A tall, stout, caespitose bamboo. *Young shoots* blackish and green, tip acute; culm sheaths covered with blackish hairs; blade erect, yellowish; margin of the shath greenish-yellow. *Culms* dull greyish-green, 12-20 m tall, 5-10 cm in diameter at the base; nodes swollen, with a white ring above each node, hairy below; *internodes* 6th & 8th generally longest, length varying from 18-30 cm, sometimes slightly sulcate, silvery-brown pubescent, wall thick; branches from all nodes from base to upwards, sometimes branches of the lower nodes smaller and recurved like spine; *branch buds* 4-5 cm broad, 2-3 cm wide, triquetrous, slightly 2 keeled towards the top, ciliate along the keels. *Cum sheaths* green when young, deciduous, falling off at the time of branch emergence; *sheaths* dimorphic, those of lower nodes much shorter and broader than upper ones, 16-35 cm long, 14-20 cm broad at base, densely appressed



hairy on the upper surface, ciliate on the edges and on the rounded top, sheath proper 14-25 cm long, oblong-elongated; *imperfect blade* short, triangular, decurrent into short, fringed auricles, upper one 25-35 cm long, 20-25 cm broad, glabrous, striate, truncate above, ciliate on the edges; lower imperfect blade 15-20 cm long, 7-10 cm broad, sharp at apex and with recurved margin, hairy below, striate above, rounded at the base, and then again decurrent on the sheath to form a narrow band bearing a few long ciliate hairs; *ligule* 5-8 mm, denticulate. *Leaves* oblong lanceolate, 9-30 cm long, 2-5 cm broad, base rounded, tip acuminate, hairy in young stage, both the surface, glabrous in old stage; veins scabrous, secondary veins 7-9 pairs, intermediate 6-7, many pellucid



glands which often give the appearance of prominent transverse veinlets are found on the lower surface; *sheath* striate, appressed-white hairy, truncate above with a narrow callus and sometimes furnished with few stiff, wavy deciduous bristles; *ligule* membranous, triangular.





Inflorescence a large, compound panicle, bearing spicate branches with bracteate dense heads of spikelets, rhachis pubescent. *Spikelets* ovoid-lanceolate, flattened, 6-8-florets, 9-14 x 7.5-13 mm, the upper and the lower floret sterile the others hermaphrodite, rhachilla hidden; *glumes* none to 2, ovate-acute, many nerved; *lemmas* membranous, ovate, many nerved, mucronate, fimbriate on the margins, straw-coloured or brown; *paleas* as long as the lemmas, ovate-acute, 2-keeled, long ciliate on keels, with four intracarinal anastomosing nerves. *Lodicules* 3, ovate or obovate, 3-5 nerved, fimbriate. *Stamens* not exserted; *anthers* apiculate with few silky hairs. *Ovary* broadly ovoid, acuminate, hairy; *style* hairy; *stigmas* 3, plumose. This species is often confused with *Dendrocalamus hamiltonii,* but can be recognized by its long leafless shoots arising from the lower nodes; leaves with rounded base and hairy sheaths and ciliate margins of culm sheaths.

Distribution: This bamboo is almost found under cultivation only. Eastern Uttar Pradesh, Bihar, Orissa, plains of West Bengal, Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Tripura. Nepal, Bangladesh, Annan, Java, Australia and South Africa.

Phenology: This species flowers at long intervals and therefore it has been rarely collected in flowers. According to Gamble (1896) it flowered in Purnea district (Bihar) in 1849, Golpara (Assam) in 1876, Kamrup (Assam) in 1889 and Gorakhpur (Eastern Uttar Pradesh) in 1881. In recent years it has gregariously flowered during 1983-85 in Baldi and Hazirhat, Bangladesh (Banik and Alam, 1987). In villages of eastern Uttar Pradesh during 1986, at Mala in Pilibhit Forest Division, also around Kanpur during 1987 (Rawat, 1987), and in foot hills of North Bengal during 1989-90 (Sahoo, 1991). Stapleton (1987) stated that sporadic flowering has been observed in Kathmandu, Nepal for several years but no seed has been produced. Barooah (1999) mentioned its sporadic flowering in 1998 from Khorahat near Bilasipara, Dhubri district, Assam. On the basis of its flowers/seeds deposited in Carpological Museum of Forest Research Institute, Dehra Dun, it can be said to have flowered in May 1921 in Cachar, Silchar in Assam. A survey of herbarium specimens revealed that a flowering specimen of this species was collected by J.Thomson somewhere in Assam in May 1928. During March-April 1986 the author observed its sporadic flowering in Drupong Range, Chessa, and in 2012 at Sangram, district Kurung Kumey, Arunachal Pradesh.

In recent years it has gregariously flowered during 1983-85 in Baldi and Hazirhat, Bangladesh.

Uses: It is the best and strongest species of Assam and Bengal, used for building purposes, agricultural implements and scaffolding. When seasoned by immersion in water, it becomes very durable and insect resistant. It is used for making agarbati sticks in Tripura.

Bambusa bambos (Linn.) Voss.

Bambusa bambos (Linn.) Voss, Besch. Pflanzen deutsche Gaertn. 2:584. 1896. *Arundo bambos* Linn., Sp. Pl. 81. 1753. *Bambusa arundinacea* (Retz.) Willd., Sp. Pl. 2:245. 1799. *Bambos arundinacea* Retz., Obs. Bot. 5:24. 1789. *Bambusa spinosa* Roxb. ex Buch.-Ham. in Trans. Linn. Soc. 13:480. 1822 (*non*. Bl. ex Nees). *Bambusa orientalis* Nees in Linnaea 9:475. 1835 (*nomen nudum*). *Bambusa arundinacea* var. *orientalis* (Nees) Gamble in Ann. Roy. Bot. Gard. Cal. 7:53. 1896.

English name: Spiny bamboo, Thorny bamboo.

Local Name : *Wakantha* (Garo)





Where to see it in Meghalaya: This is commonly found under cultivation . **East Garo Hills:** Bhalughat, Mahendraganj Range, Rongrenggiri, Darugre. **West Garo Hills:** Damalgre. **South Garo Hills:** Angratoli Reserve. **South-West Garo Hills:** Okhapura, Chongpotgri, Mellium.

A tall, graceful, thorny bamboo with curved branches. *Young shoots* deep purple with few white stripes. The tip of growing shoots become blackish or yellowish with curled auricles, ciliated blades erect, tip blunt, glabrous. *Culms* strong, hollow, dull to deep green, 10-30 m tall, 2.7-10 cm in diameter at base; *nodes* comparatively larger in diameter than the internodes, *sheath scar* thick, uniform, remnants of sheath fibre present, in young culms a whitish or brownish band of pubescence above the nodes; supra nodal ring present, remnants of verticals of aerial root present on the supra nodal ridge up to 10th node; *branch bud* oval, 2-keeled, keels ciliate; *internodes* 15-30 cm long, 5th to 8th are generally longest; root verticles up to the mid culm in few culms, distinctly sulcate; branches from all nodes from the base upwards; upper branches horizontal or ascending and producing a gently arching fan-like plum, central dominant branch produce first with one or two laterals produced soon from its lower nodes of the culm,

the branches recurved and bending downwards, often spine like, usually three branches produced at the upper nodes, leafy, with some branches spine like; *spines* curved, up to 4.5 cm long. *Culm sheaths* 15-45 cm long, 12-30 cm broad at base, leathery, deciduous, fall off at the time of branch emergence, elongated to cylindrical; *sheaths* up to 25 cm long, elongated, margin plaited, adaxial surface glabrous to pubescent with blackish hairs, apex rounded; *auricle* inconspicuous, if present ciliated, bordering the top of the sheath; *imperfect blade* 4-12 cm long, up to 6 cm wide above the base, reflexed, base cordate, apex acute, adaxial surface covered with thick black or blackish brown felt of hairs, margins ciliated. *Leaves* lanceolate to linear, variable in size from 6-22 cm long, 1-3.5 cm broad, acute, both the surfaces glabrous; secondary veins 4-6 pairs; sheath thick, ligulate, pubescent, auricled with silvery bristles, in young leaves the sheath is ciliate along the edges and at the mouth; *ligule* very small, membranous with ciliolate rim.



Inflorescence a very large panicle; branches spicate with few loose clusters of spikelets, each cluster with about five spikelets. *Spikelets* pale, lanceolate, acute, 1.75-2.5 cm long, sessile, with 4-6-florets, rhachis dull, smooth; *glumes* 2 or absent, ovate, lanceolate, acutely mucronate, 5-7 mm long; *lemmas* smooth at the apex, often entirely glabrous, as long as the glumes; *paleas* narrower than the lemmas, somewhat longer, 2-keeled, keels ciliate, rhachilla hardly visible. *Lodicules* 3, two sub-obtuse, the third lanceolate. *stamens* 6; *anthers* yellow, sometimes with an apiculate bristle. *Ovary* elliptic-oblong; *style* short, glabrous; *stigma* 2 or 3, long, plumose. *Caryopsis* 5-8 mm long, oblong, grooved on one side.



Distribution: Jammu & Kashmir, Punjab, Uttar Pradesh, Bihar,Orissa, West Bengal, Assam, Tripura, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, Maharashtra, Karnataka, Goa, Gujarat, Rajasthan. Nepal, Bangladesh, Myanmar, Thailand, Sri Lanka, Indonesia, Malaya, Southern China, Vietnam and cultivated in Amani Arboretum in North Tanzania. Cultivated in Mizoram, Meghalaya, Manipur and Nagaland.

Phenology: There is only record of gregarious flowering of this species is from Garo hills Meghalaya. There are different opinions, regarding flowering year/period of *Bambusa bambos*. Nicholls (1895) stated that "*Indian, whom he requested about the flowering age of Bambusa arundinacea, replied that between its successive seeding a child would be an adult, and his son again would reach manhood*". However, in Thailand, it was reported to flower every year (Anantachote, 1987). Gamble (1896) stated that roughly, it may be said to flower about every 30 years. Gupta

(1928) stated that it appears to flower gregariously at intervals of 30-32 years. Blatter (1931), after analyzing all the flowering records available from its natural zone, concluded that its flowering cycle is 30-34 years. He also pointed out that at Dehra Dun, where it had been planted, it has a cycle of 45 years. Janzen (1976) considered it to be between 30-32 years, whereas Gadgil and Prasad (1984), Gaur (1987) and Dransfield and Widjaja (1995) mentioned a flowering period of about 45 and 30-45 years respectively. According to Banik (2000), this species in the coastal part of India reported to exhibit 30 year inter seeding period while in northern India it is 45-52 years. In recent past, Tripathi and Basu (2010) stated average flowering cycle between 45-48 years, while Nair and Rajesh (2010) stated it as 50 years. Veller *et al.* (2015) stated it to be 32 years. Therefore the cycle of flowering does appear to vary in different localities for this species. Following table gives the regarious flowering of the bamboo in the world.

Table-39:Recent record of Gregarious flowering.

State	Year	Nature of Flowering	Place	Source
UTTARAKHAND	2014-16	Gregarious	Haldwani Division	Naithani & Sanwal, (2017)
	2014-16	Gregarious	Central Tarai Forest Division	Naithani & Sanwal, (2017)
	2014-16	Gregarious	Western Tarai Forest Division	Naithani & Sanwal, (2017)
	2014-16	Gregarious	East Tarai Division	Naithani & Sanwal, (2017)
	2014-16	Gregarious	Udham Singh Nagar	Naithani & Sanwal, (2017)
	2014-16	Gregarious	Dehra Dun	Naithani & Sanwal, (2017)
UTTAR PRADESH	2014-16	Gregarious	Lakhimpur, Gonda, Muzaffarnagar, Saharanpur, Bahraich	Naithani & Sanwal, (2017)
	2014-16			
	2014-16			
	2014-16			
	2014-16			

Table-40: Past records of gregarious flowering of Bambusa bambos

State	Year	Nature of Flowering	Place	Source
Andaman & Nicobar Islands	2008	Gregarious	Bukultala, Kishori Nager and Potatang	Naithani *et al.* (2008)

Andhra Pradesh	1889	Gregarious	Nallamelai hills, Kurnool, Andhra Pradesh	Gamble (1896)
	1894	Gregarious	Cuddapah, Andhra Pradesh	Gamble (1896)
	1987-88	Gregarious	Nallamelai hills Kurnool district Andhra Pradesh	Rao (1988)
Assam	1928	Gregarious	Nawagang Division, Assam	Adhikari (1928)
	1974-1977	Gregarious	Assam Valley	Gupta (1982)
	1997	Gregarious	Bara Azara, Nalbari Town, Assam	Barooah (1999)
	2008	Gregarious	Bajali area of Indo-Burma hotspot region, Assam	Sarma *et al.* (2010)
Bihar & Orissa	1812	Gregarious	Orissa	Gamble (1896)
	1896-1899	Gregarious	Puri and Angul division Orissa	Haines (1921)
	1912	Gregarious	Angul Division Orissa	Nicolson (1945)
	1913	Gregarious	Angul and other localities in Bihar and Orissa	Troup (1921)
	1918		Mal, Patia and Dhani R.F (Orissa)	Mathur (1947)
	1922-24	Gregarious	Puri Division	Anon. (1922), Derry (1926), Sharma (1989)
	1944	Gregarious	Angul Division Orissa	Nicolson (1945)
	1969	Gregarious	Nowrangpur Division Koraput, Orissa	Das (1969)
	1976	Gregarious		Das (1976)
	2008	Gregarious	Mal Reserve Forest (Nayagarh), Dhani, Chakadapathar Demarcated Protected Forest (Khurda) Orissa	Nair and Rajesh (2010)

Goa	1969	Gregarious	Valpoi North Goa	Herbarium record
Gujarat	1910	Gregarious	Dangs, Gujarat	Troup (1921)
	1954	Gregarious	Pili, Gujarat	Patil (1968)
	2007-08	Gregarious	Dangs Gujarat	Personal observation of author (HBN)
Karnataka	1804, 1836, 1866	Gregarious	Wynaab and Coorg, Karnataka	Kurz (1876) Brandis (1899)
	1866	Gregarious	Malabad, South Kanara, Wynaab and Coorg, Karnataka	Brandis (1906)
	1910, 1913-15	Gregarious	Kanara, Belgum, Dharwad Coorg, Karnataka	Troup (1921)
	1977-1980	Gregarious	Coorg, Karnataka	Gadgil (1980)
	1977-1981	Gregarious	Sampaje area Oakshina Kannada, Karnataka	Prasad and Gadgil (1985)
Kerala	1918	Gregarious	Tunacadavu Range, Cochin, Kerala	Menon (1918)
	1951-62, 1957-1962		Nilambur Wynnad, Kerala	Iyppu (1964)
	1991-1992	Gregarious	Wyanad, Kerala	Seethalakshmi and Kumar (1990) Seethalakshmi *et al.* 2010
	1994-95		Attappady, Kerala	Seethalakshmi and Kumar (1990)

Madhya Pradesh	1865		Balaghat, Madhya Pradesh	Gamble (1896)
	1869	Gregarious	Satpura, Madhya Pradesh	Troup (1921)
	1885	Gregarious	Narsingpur, Central India	Gamble
	1916-1917	Gregarious	Balaghat, Madhya Pradesh	Troup (1921)
	1921	Gregarious	South Mandala, Madhya Pradesh	Sharma and Tomar (1964)
	1937-38	Gregarious	Jhabua, Madhya Pradesh	Sharma and Tomar (1964)
	1961	Gregarious	Jhabua, Madhya Pradesh	Sharma and Tomar (1964)
	1989		Jabalpur, Madhya Pradesh	Naithani (1993)
Maharashtra	1874-1884	Gregarious	Bombay, Maharashtra	Troup (1921)
	1901	Gregarious	Maharashtra	Querishi (1983)
	1905-1918	Gregarious	Bombay, Maharashtra	Querishi (1983)
	1933-1934	Gregarious	West Berar Division, Nagpur	Sagereiya (1941), Bhogle (1964)
	1942	Gregarious	Maharashtra	Querishi (1983)
	1959-1960		Thana and Nashik, Maharashtra	Sagereiya (1941), Bhogle (1964)
	1960		Koyan Valley- Satara district , Maharashtra	Sagereiya (1941), Bhogle (1964)
	1982	Gregarious	Maharashtra	Querishi (1983)
Meghalaya	**1929**		**Garo hills Meghalaya**	**Anon. (1929), Trevor (1929)**
Punjab	1990		Punjab university, Chandigarh	Shor (1997)

Tamil Nadu	1896		Walayar Forest, Coimbatore	Troup (1921)
	1912-15		Wynnad, Kollegal, Coimbatore	Troup (1921)
	1915-1917, 1920-1922, 1926, 1928-1933	Gregarious	Coimbatore North Salem Coimbatore North Trunelveli, Coimbatore near Walliyear, slopes of Nilgiris	Aslam (1964)
Kerala, Karnataka, Tamil Nadu	1905-06 1912-13 1917-18 1944-45	Gregarious	Kerala, Karnataka, Tamil Nadu	Kadambi (1949)
Tripura	2001	Grearious	Tulakona and Madhupur, Tripura	NMBA (2009)
Uttarakhand	1832, 1836	Gregarious	Dehra Dun, Uttarakhand	Smytheis (1881)
	1881	Gregarious	Dehra Dun, Kumaon, Uttarakhand	Broun (1886), Nicholllos (1895), Blatter (1929)
	1882	Gregarious	Dehradun, Uttarakhand	
	1900	Gregarious	Dehra Dun	Troup (1921)
	1925	Gregarious	Dehra Dun	Gupta (1928)
	1926		Dehra Dun	Bodeker (1930)
	1937	Gregarious	Dehra Dun	Herbarium record

Uttar Pradesh	1880		Pilibhit, Kheri, Bahraich, Gonda, Gorakhpur, Uttar Pradesh	Wood (1881)
	1941	Gregarious	Saharanpur, Uttar Pradesh	Mohan (1992)
	1990	Gregarious	Saharanpur, Uttar Pradesh	Mohan (1992)
	2014-2016	Gregarious	Lakhimpur, Uttar Pradesh	Pers. Com. Dr. P. Verma, F.R.I., Dehra Dun
West Bengal	1946	Gregarious	Midnapur West Bengal	Herbarium record
India	1970-71	Gregarious	Throughout	Varmah and Bahadur (1980)
Bangladesh	1976-1978 1988	Gregarious	Chittagong Dhalghat, Koechia station, Sylhet	Banik (2000)
Brazil	1804, 1836, 1886	Gregarious	Brazil (Introduced, probably 1804 seed from Coorg)	Dutra (1938)
Australia	1990		Darwin	Poudyal (2006)

Source (Naithani and Sanwal 2017)

Bambusa cacharensis Majumdar

Bambusa cacharensis Majumdar in Bull. Bot. Surv. Ind. 25(1-4):236. Pl. 3. 1983.
Local Name : *Ba* (Jaintia)

Where to see it in Meghalaya: This bamboo is commonly cultivated. **East Jaintia Hills:** Umkiang. **West Jaintia Hills:** Pasadwar, Muktapur, Dawki, Pdengskab, Lakroh, Syndai, Amdoh, Umlari, Twahusdiah, Sonapyrdi.

Arborescent. *Young shoots* without white powdery excretions below the culm sheaths. *Culms* erect, 20-21 m high, 5-10 cm in diameter. *Culm sheaths* 12-15 cm long, 25-27 cm broad, covered on the back with chocolate-brown, sharp, spicular hairs; *imperfect blade* orange-yellow and spreading at right angles to the axis; auricles wavy with thick rigid cilia on the margins and short dense hairs outside on



the body. *Leaves* 16-20 cm long 1.5-2.5 cm broad, linear.



Inflorescence a panicle occupying the whole culm. *Spikelets* aggregated at the nodes of ultimate branchlets, with 3-6-florets, 3-3.5 cm long, florets 10-15 mm long, glossy green, rhachilla internodes articulate; *glumes* two, unequal, 5-8 mm long, many nerved; *lemmas* 10-14 mm long, many nerved. *Paleas* small, 2-keeled, keels scabrous. *Lodicules* 3, ciliate. *Stamens* 6.

Distribution: Assam, Meghalaya, Tripura and Manipur. Bangladesh.





Phenology: Majumdar (1983) while describing this bamboo did not mention whether it has flowered sporadically or gregariously. Alam (1999) stated that it flowered at Sylhet in March 1889 and March 1984. The intervals between these two flowering phases is about 94 years. An intermediate flowering cycle might had been missed. Speculating an intermediate flowering the cycle may be estimated as 45±5 years. According to Government of Tripura it has flowered in 2001 at Tulakona & Madhupur under Sadar Forest Division, Tripura. Singh *et al.* (2003) published flowering of *Bambusa cacharensis* in southern part of North east India. Debbarman *et al.* (2013) from Tripura (West) Devi and Bhattacharya (2013) have reported flowering in Barak Valley, Assam. P.Kumari (2014) has mentioned its flowering in 2004 from Jaintia Hills, Meghalaya without giving any reference. Author in 2013 has found its sporadic flowering is Pasadwar, Jaintia hills, Meghalaya. Debbarman *et al.* (2013) mentioned flowering, vivipary in natural seedlings of *Bambusa cacharensis.*

Uses: It is the best bamboo which is mainly used for construction and general purposes.

Bambusa jaintiana Majumdar

Bambusa jaintiana Majumdar in Karthikeyan *et al.,* Fl. Ind. Enum. Monocot. 281. 1989; Pushpakumari & P.J.Singh in NELUMBO 52:117.2010.

Local Name : *U Skhen,* (Khasi);, *Skhen Pnar, Thengrangrai, Thning* (Jaintia Hills); *Wathibok, Wathesa, Kolongki* (South, East and West Garo Hills)

Where to see it in Meghalaya: This bamboo is commonly cultivated thoughout Meghalaya. **East Khasi Hills:** 4 ½ Mile Tissue culture lab, Upper Shillong, Ward's Lake, Raj Bhawan (Shillong), Tyrna, Sohra, Pommura and Shella.**West Khasi Hills:** Nongstoin, Risiang, Nongtraw. **Mawkyrawt district:** Mawsawdom, Phottdgi, Mawranglang.**East Jantia Hills**: Almost all villages. **East Garo Hills:** Nengkhra, Bonsamgre. **West Garo**



Hills: Tawwakgre, Rombagre, Machurigre. **South West Garo Hills:** Damalgre, Balaegre, Dawagiri. **Ri- Bhoi:** Nonpoh, Barapani.

Clumps densely tufted; profuse branching towards the base; crown of matured culms spreading. *Young shoots* yellowish green with white blooms on back of the sheath, silvery bristled on the auricles; *blades* erect with acuminate tips. *Culms* dull green, glaucous, 3-6 m tall, diameter 0.8-3.0 cm at base; *internodes* slightly sulcated just above the node; n*odes* slightly greater than the internodes, nodal line single, horizontal, and no distinct supra-nodal ridge; b*ranch buds* ovate, about 2 cm long, 2-keeled, slightly ciliated along the keels; b*ranches* from base to mid culm, the middle one larger and the laterals are subequal. *Culm sheaths* green when young, conical including the blade; *sheath* proper 10-14 cm long, 12-15 cm broad at base, gradually tapering, into an obtuse tip, both the surfaces glabrous; auricles two, unequal, attached with the side of the sheath, free from the blade, margins long bristled; blade conical, cordate, acuminate, both the surfaces glabrous. *Leaf sheaths* glabrous, keeled on the back, auricled, auricles long bristled, bristles 10 mm long; *blades* lanceolae, 8.5-33 cm long, 1.5-5.0 cm broad both the surfaces glabrous.



Inflorescence branched leafless panicle, branchlets spicate with clusters of spikelets sometimes in axil of bract; rachis rounded, glabrous. *Spikelets* cylindrical, 1-5 cm long, 4-7 flowered, with 2-3 gemmiparous glumes and terminal 2-3 convolute imperfect flowers; rachilla 6-7 mm long, flattened, clavate,glabrous; *empty glume* 1, ovate acute, glabrous, faintly multi-nerved; *lemma* 1.5-2.5 cm long, ovate-acute, fine hairy near apex on inner surface, faintly multinerved, transverssed veined on inner surface, margins smooth; *palea* spathulate, shorter than lemma, 2-keeled, ciliate at keels, 7-nerved in between keels, 3-5 nerved on either side; faintly transverse veined and minutely hairy on inner surface, margins smooth; *lodicules* 3, variable 1-1.2 cm long, linear or sometimes one obliquely truncate above, long white fimbriate above, thick, much dark below; stamens 6,3-5 mm long, exserted, emarginate or apiculate at tip; *ovary* c.2 mm, oblong, narrow and long hairy at apex; style short, soon dividing into 3, 4-5 mm long, feathery stigmas.

Distribution: Assam, Meghalaya, Manipur, Nagaland, Arunachal Pradesh. Bhutan, Bangladesh.

Phenology: It generally flowers sporadically. According to Alam (1999) it has flowered in Chen Hills, Myanmar in 1903, North Cachar hills, Assam, 1915, Chittagong, 1978 and



Gajipur 1982 & 1986 Bangladesh. The interval flowering phases range from 63-83 years. Speculating an intermediate flowering, the cycle is estimated 35 ± 5 years. It has flowered in Khasi Hills in 1941 and in 2005 at Garo hills (P. Kumari and P.Singh, 2014). In April 2007 author has observed in profuse flowering at Romingri, East Garo Hills and also observed it in on June 2013 at Dilsinggre, South Garo Hills and Phulwari West Garo Hills.



Uses: This is very useful bamboo in Jaintia hills for all purposes.

Note: This species is often confused with *Bambusa pallida* Munro and *Bambusa pseudopallida* Majumdar.

Bambusa majumdarii P. Kumari & P. Singh

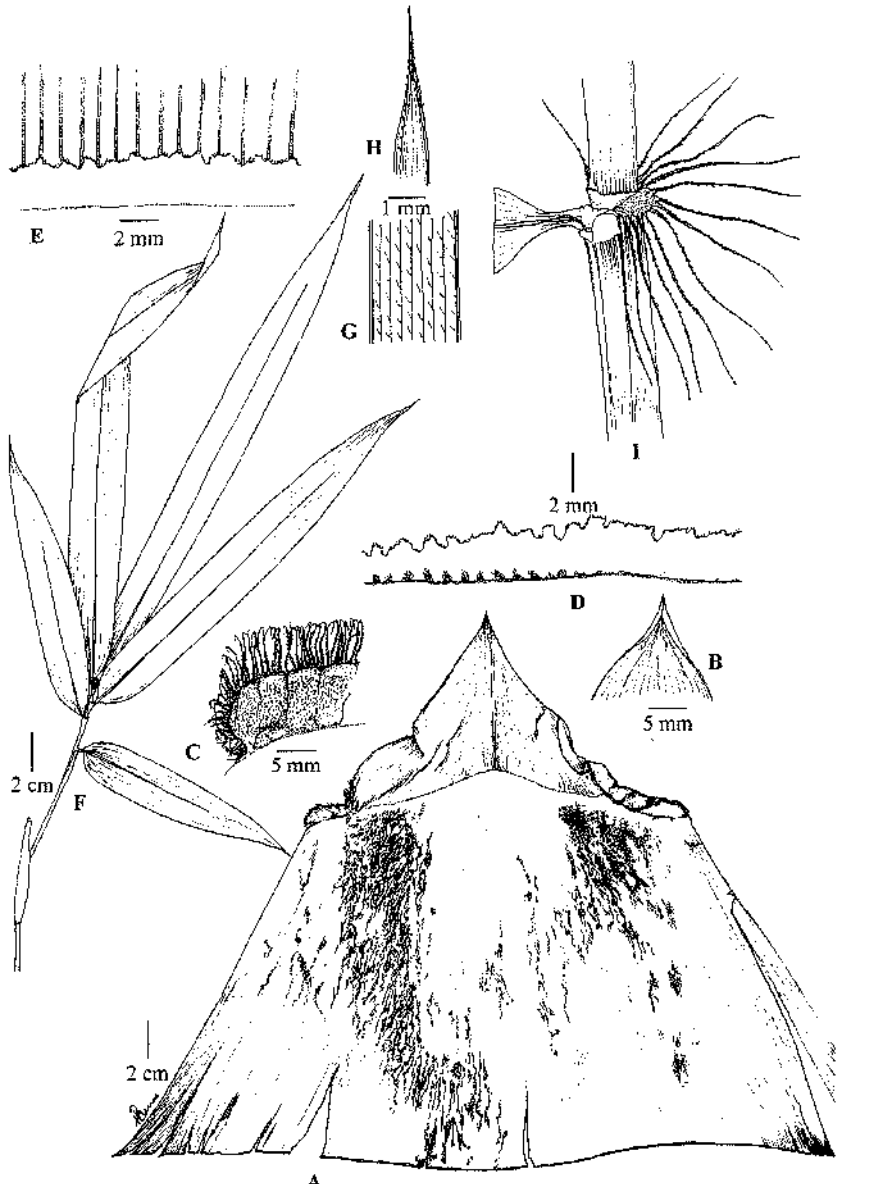
Bambusa majumdarii P. Kumari & P. Singh in Kew Bull. 64: 565. 2009.

Where to see it in Meghalaya: West Garo Hills: Near Tura

Arborescent, erect, loose-clumped bamboo. *Rhizome* pachymorph. *Culms* c. 10 m high, 5-8 cm in diameter, light green with whitish pruinose deposition; nodes even; internodes 30-45 cm long, thick walled; nodal bud oval; branching in triple pattern with one dominating and subsequent smaller branches, present on all nodes except few lower ones. *Culm-sheaths* shorter than internodes, deciduous, triangular, broader than long, yellowish-brown, young ones whitish green with white stripes; sheath proper 19-20 cm long, 35-36 cm broad at base, attaining into 18-19 cm wide convex top, brown-blackish hairs appressed in patches on outer surface, smooth shining on inner surface; imperfect blade persistent, erect, triangular, c.7 cm long and 12 cm broad at rounded base, continuing with auricles, terminating into incurved, pointed apex, striate, glabrous on both surfaces except few cilia at apex on inner surface, margins ciliate at base; ligule c.2 mm long, unevenly serrated, ciliate at mouth, with few short hairs in groups at base underneath imperfect blade; auricles somewhat unequal, dissimilar, c. 1 cm high, 2.5-3.5 cm broad, wavy, pubescent on outer surface, fringed with c. 5 mm long, dense ciliolate bristles. *Leaves* 5-6 per twig; leaf-blades lanceolate, 9-29 cm long, 1.5-4.2 cm broad, lower subequally rounded and apical attenuate at base, gradually and acuminately terminating into incurved, scabrous,c.2 mm long apex; glabrous on adaxial surface except scabrid nerves along one margin, hairy on abaxial surface, serrated on both margins; midvein prominent, glabrous, secondary veins 8-10 pairs, tertiary veins 7, cross-veins not prominent; pseudopetiole c.2 mm long; leaf-sheath glabrous, striate, keeled, smooth at margins, ending into rounded,

smooth callus; ligule 1-2 mm long, oblique, glabrous, ciliate at mouth; auricles crescent shaped, reflexed, bearing c.1 cm long, thin ciliolate fringers.

Distribution: Endemic to Meghalaya.



Bambusa majumdarii P.Kumari & P.Singh

A.culm-sheath; B.imperfect blade apex (inner surface); C. auricles; D. ligule underneath imperfect-blade; E. ligule with imperfect-blade base; F. leafy twig; G. leaf abaxial surface; H. leaf-apex; I. leaf-sheath.

Source: P. Kumari and P.Singh (2014)

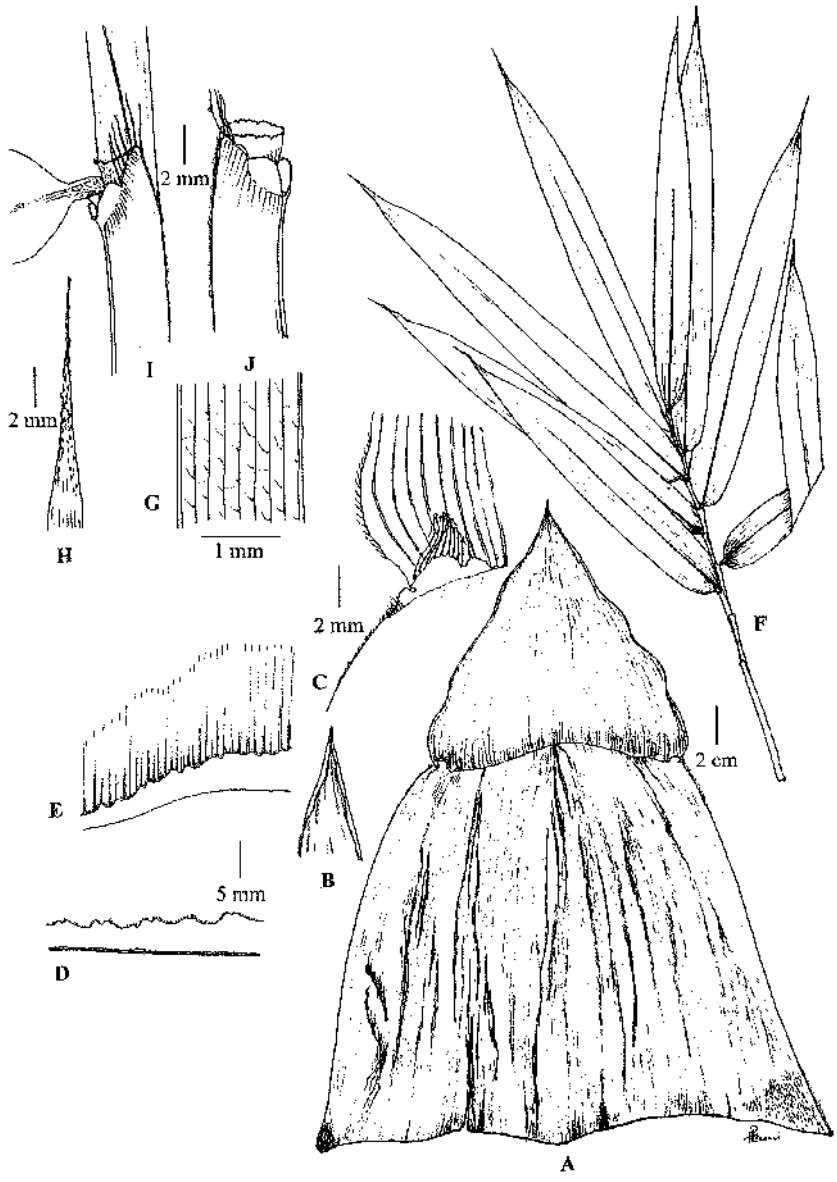
Bambusa mohanramii P. Kumari & P. Singh

Bambusa mohanramii P. Kumari & P. Singh in Kew Bull. 64: 567. 2009.

Where to see it in Meghalaya: East Jaintia Hills: Khliehriat. **East Khasi Hills:** Mawryngkneng.

Arboreal, erect, clump-forming bamboo. *Rhizome* pachymorph. *Culm*s 10-15 m high, 5-6 cm in diameter, dark-greyish green; nodes slightly raised, with whitish ring below and root scars above nodal line, rootlets on lower 9-10 nodes; internodes terete, 30-40 cm long, thick-walled, semisolid; nodal bud ovate; branches in triple pattern, present on all nodes except a few lower ones, *Culm-sheaths* deciduous, triangular, shorter than internodes, yellowish-brown, leathery; sheath proper 19-21 cm long, 24-28 cm broad at base, attaining gradually from one side and somewhat roundly from another into 11-13 cm wide, slightly convex, rounded top; glabrous on both surfaces except a very few brown-blackish hairs appressed on one corner at the base on outer surface, shining, smooth on inner surface; imperfect blade persistent, erect, smaller than sheath proper, triangular, equally broad or broader than the top of sheath proper, rounded at base, terminating into incurved pointed apex, glabrous on both surfaces, minutely ciliate at margins; ligule up to 1 cm long; dentate, ciliate at mouth, glabrous underneath blade; auricles similar, short, rounded, somewhat lobed with two small lobes on either side, short ciliate, cilia deciduous. *Leaves* 8-10 per twig; leaf-blades lanceolate, 15-27 cm long, 2-3 cm broad, lower subequally rounded and apical attenuate at base, gradually and acuminately terminating into twisted, scabrous, c.5 mm long apex; glabrous on adaxial surface except scabrid nerves along one margin, minute hairy on abaxial surface, serrated on both margins; midvein prominent, glabrous, secondary veins 10-11 pairs, tertiary veins 7-9, very faint pellucid dots like cross veins observed; pseudopetiole with few cilia first, afterwards glabrous; leaf-sheath glabrous, striate, thin keeled, ciliate at margins, ending in rounded, smooth callus short ciliate at mouth; ligule c.1 mm long, slightly oblique, glabrous or with few cilia near petiole; auricles obscure, mouth and rounded, having c.2 mm long, deciduous cilia.

Inflorescence branched leafless panicle, branches bearing globose or semiglobose (in young) heads; rachis striate, hispid towards apex. *Spikelets* 2-2.5 cm long, 5-8 flowered, all fertile; empty glumes 2-4, 4-8 mm long, ovate, mucronate, multinerved, minutely ciliate on margins at apices, glabrous on outer surface, white pubescent at apex on inner surface; lemma ovate, acuminate at apex, 12-13 mm long, multinerved, glabrous on outer surface, faintly cross-veined and hairy on inner surface, margins short-ciliate on upper half, smooth below; palea shorter than lemma, c. 10 mm long, oblong, 2-keeled, long ciliate at keels, 3-5 (-7)-nerved in between keels 2-nerved on either side, faintly cross-veined and minutely pubescent on inner surface, glabrous on outer surface except few scattered minute cilia, margins short ciliate; stamens 6, c.6 mm long, base saggitate, apex penicillate; ovary 1-2 mm long; ovate, hairy, continuing into 2-3 mm long, hairy style which divides into 3, plumose, 7-8 mm long purple stigmas; lodicules 3, c.6 mm long,



Distribution: Endemic to Meghalaya.

Bambusa mohanramii P. Kumari & P.Singh

A.culm-sheath ; B.imperfect blade apex (inner surface) ; C. auricles ; D. ligule underneath imperfect-blade ; E. ligule with imperfect-blade base ; F.leafy twig ; G. leaf abaxial surface ; H. leaf-apex ; I. & J. leaf-sheath.

Source: P.Kumari and P.Singh (2014)

Bambusa multiplex (Lour.) Raeusch. ex J.A. & J.H. Schults

Bambusa multiplex (Lour.) Raeusch. ex J.A. & J.H. Schults in Syst. Veg. 7:1350. 1830; *Arundo multiplex* Lour. Fl. Cochinch. 58. 1790; Camus, 132. 1913. *Ludolfia glaucescens* Willd. in Ges. Nature f. Freunde Berl. Mag. 2:320. 1808. *Bambusa glaucescens* (Willd.) Sieb. in Trans. Linn. Soc. Lond. 26:89. 1868. (*nom. invalid*) ex Merrill in Philip. J. Sci. 7c:230. 1912. *Arundinaria glaucescens* (Willd.) Beauv., Ess. Agrost. 144, 152. 1812 (index). *Bambusa nana* Roxb., Fl. Ind. Carey ed. 2:199. 1832. *Bambusa glauca* Lodding ex J.A. & J.H. Schults in Syst. Veg. 7:1355. 1830. *Bambusa floribunda* Zoll. & Mer. ex Steud., Syn. Pl. Gram. 330. 1854. *Bambusa viridiglaucescens* Carr. In Rev. Hortic. 292. 1896.

Where to see it in Meghalaya: East Khasi Hills: Planted at Ward's Lake, Shillong and Barapani. (Cultivated)





A shrubby, evergreen, caespitose bamboo. *Young shoots* slender, glabrous; *sheaths* yellowish-green; auricles caducous; *blades* erect, brown to purple-brown, spear-shaped with broad base. *Culms* 2-4 m high, 1-15 cm in diameter, green, mature one yellowish or yellowish-green, covered with waxy powder, arched above; *branching* more or less simultaneously from the 6th and above nodes, central dominant branch produced first, followed in quick succession by germination of promixal buds of several orders, only the central axis and two lateral ones greater in size than the remaining axis, the whole cluster of branches soon formed upto 20 or more in a whorl; *nodes* thickened; *internodes* 20-30 cm long, 3rd and 4th longest; sheath scar thin, uniform. *Culm sheaths* stiff, persistent or deciduous, 10-15 cm long, 5-7.5 cm broad, slightly attenuate upwards and rounded at the top, green or light red brown at first, turning yellow later, both surfaces glabrous; *imperfect blade* 5-7.5 cm long, linear, acuminate, decurrent at the base into two indistinct ciliate auricles, hairy on both surfaces; *ligule* continuous on the whole top of the sheath,

upto 1.5 mm wide, edges irregularly or shortly toothed. *Leaves* lanceolate, 5-15 cm long, 0.6-1.5 cm broad, rounded at the base into a short petiole, acuminate at tip, upper surface smooth, lower surface whitish, glabrous and minutely pubescent; main vein inconspicuous, secondary vein 3-6 pairs, intermediate 7-8, no transverse veinlets, with faint pellucid glands; *sheath* smooth, straite, ending in a prominent callus and auricled at the mouth with long white bristles when young; *ligule* very narrow.



Inflorescence short, diffused, leafy panicle with few spikelets, solitary or clustered. *Spikelets* 1.3-3.7 cm long, glabrous, straw coloured, bearing 5 or more florets, separated by 2.5 mm long rhachilla joints, terminal floret imperfect; *glumes* absent or rarely one; *lemmas* glabrous, 1.6-2 cm long, ovate-acute, many nerved; *paleas* shorter, many nerved, 2-keeled, minutely ciliate at the top. *Lodicules* 3, unequal, entire, linear, usually 2 nerved. *Stamens* long-exserted, pendulous; *anthers* obtuse or slightly apiculate, yellow. *Ovary* obovate, pubescent at the top; *style* short; *stigma* long, plumose. *Caryopsis* elliptic, furrowed, shortly hairy at the top, crowned with the base of style.

Distribution: Native of China and Japan. In India cultivated in North-east region, Dehra Dun, Indian Botanic Garden, Calcutta, Tamil Nadu, Bihar, Maharashtra. Also cultivated in Bangladesh, Myanmar, Indonesia, Pakistan, Sri Lanka, Indo China, Malaya, Iraq, Soviet Union and Europe.

Phenology: Not much has been published about its flowering behaviour. It flowered in Calcutta in 1890 (Gamble,1896). Holttum (1956) and Bennet and Gaur (1990) mentioned flowering in Germany during 1808 & 1839, Bangladesh during 1851 & 1879, Sri Lanka in 1863; Singapore in 1892. In 1893 it flowered at Japan (Blatter, 1929 a). Its flowered in 1984 in Puerto Rico, South America,Deitzer *et al.*, (1985). Banik (1987) mentioned that during 1977-78 it sporadically flowered in Bangladesh. Barooah (1999) mentioned its sporadic flowering in 1997 from Kathgaon near Mariyani, Jorhat district, Assam. Author (HBN) has observed its sporadic flowering annually in the Arboretum of Forest Research Institute, Dehra Dun.

Uses: It makes excellent, stiff, close growing hedges and is a hardy species. Used for fishing rods, flutes, basketing and handicraft. Culm used for making umbrellas.

Bambusa multiplex Lour. var. **riviereorum** R. Maire

Bambusa multiplex (Lour.) Rausch ex J.A. & J.H. Schults. var. ***riviereorum*** R. Maire, Fl. Afrique N.1:355. 1952. *B.glaucescens* (Willd.) Sieb. ex Munro var. *rivierorum* (R.Maire)







Where to see it in Meghalaya: East Khasi Hills: Ward's Lake, Shillong (cultivated).

A small miniature bamboo with solid culms, 1.3 m high, 3-5 mm in diameter. *Culms* 2-4 m high, 1-15 cm in diameter, green, mature one yellowish or yellowish-green, covered with waxy powder, arched above; *branching* more or less simultaneously from the 6th and above nodes, central dominant branch produced first, followed in quick succession by germination of promixal buds of several orders, only the central axis and two lateral ones greater in size than the remaining axis, the whole cluster of branches soon formed upto 20 or more in a whorl; *nodes* thickened**;** *Culm sheaths* stiff, persistent or deciduous, Leafy branches are always bent in a bow form, each bearing 13-23 leaves. *Leaf blade* 1.6-3 cm long, 0.3-0.8 cm broad.

Distribution: Native of China. In Indonesia and Thailand it is popular pot plant, also commonly cultivated in India as garden plant.

Uses: Widely cultivated as potted plant.

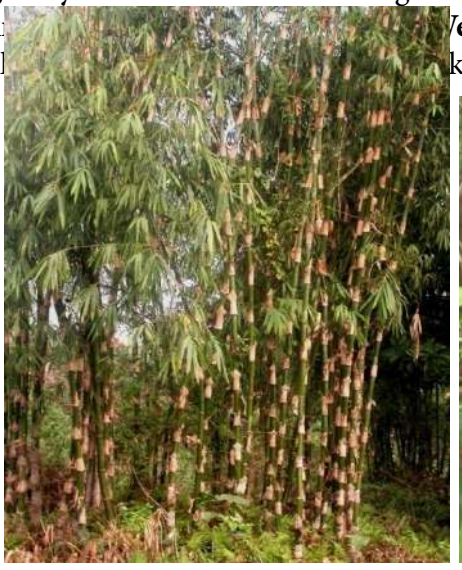
Bambusa nutans Wall.

Bambusa nutans Wall. ex Munro in Trans. Linn. Soc. London. 26:92. 1868. *B. falconeri* Munro in Trans. Linn. Soc. Lond. 26:95. 1868. pp. *B. teres* Buch.-Ham. 881. (Wall. Cat. 5026, B. *nom. nud.*) ex Munro in Trans. Linn. Soc. Lond. 26:95. 1868. *B.nairiana* P.Kumari & P.Singh, Bamboos Meghalaya 51.Pl. 12.2014 *syn.nov. Gigantochloa tekserah* E.G. Camus, Bambuses 141. 1913. *syn.nov*.

Local name: *Taksharh, Wa'sin, Wa'sim* (Garo).

Where to see it in Meghalaya: East Khasi Hills: Nongshken, Shella, Tangmang. **West Jaintia Hills:** Near Umk[illegible]**est Garo Hills:** Samphalgiri. **East Garo Hills:** Pakwal[illegible]k.







Moderate-sized,evergreen, caespitose with creeping rootstock. Culms 10-15 m tall, 5-10 cm in diameter, loosely clumped, much-branched above, usually unbranched or thinly branched below, striate, green, smooth, not shining, white-ringed below the nodes; *nodes* slightly raised, often hairy, lower ones bearing rootlets; *internodes* usually 25-45 cm long, thick-walled. *Culm sheaths* variable, usually 10-23 cm long and upto 30 cm long and upto 30 cm wide at base, covered on the back with appressed, scattered, black hairs, the base bearing a ring of soft, deciduous hairs; roundely truncate at top; *imperfect blades* of the lower nodes 15-23 cm long and very broad, that of a middle nodes shorter, acute, margins recurved, clothed within with appressed black hairs, rounded at the base and again decurrent on the top of the sheath, auricles large, wavy, one usually erect, the other decurrent, both densely furnished with long, curved bristles; *ligule* 2-2.5 mm, smooth, dentate. *Leaves* 15-25cm long, 2-3.5 cm broad, linear-lanceolate, acuminate at apex, rounded and usually oblique or attenuate at the base, ending above in a twisted, scabrous



point, green on both surfaces when young, upper surface dull-green on maturity, glabrous except the scabrid hairs on the midrib and marginal veins, lower surface glaucous, glabrous or slightly hairy, scabrous on the edges, main vein rather narrow, prominent, pale beneath, secondary veins 7-10, intermediate 8-9, pellucid glands frequent; petiole-like base 3-5 mm long; *leaf sheaths* striate, hairy when young, ending in a smooth callus and produced in a falcate auricle with a few bristles; *ligule* elongated, obtuse, hairy.

Inflorescence a stiff panicle bearing spicate branches with clusters of stiff, erect spikelets in bracteate heads, rachis smooth. *Spikelets* many, sterile or bearing gemmiparous glumes, few fertile, 1.4-2.5 cm long, glabrous, acute; *empty glumes* 2-3, glabrous, mucronate, gemmiparous; fertile flowers 3-5; *flowering glumes* ovate, acute, mucronate, many-nerved, minutely hairy within; *palea* flattened, shorter than flowering glume, ovate, 2-keeled, with the long, white ciliate on the edges of the keels, overlapping; rhachilla clavate, hairy, ciliate at the top, uppermost 2-3 flowers, usually imperfect. *Lodicules* 3 broad, obtuse, long fimbriate, fleshy at first many-nerved, one narrower than the other two. *Stamens* 6; anthers long apiculate or slightly penicillate at apex. *Ovary* sub-obovate, stalked, glabrous below, pubescent above; style short, pubescent; stigma 2-3, shortly plumose, twisted, nearly glabrous. *Caryopsis* oblong, obtuse hairy on the top.

Distribution: Naturally occurring in Sub-Himalayan tracts from Yamuna eastwards to Arunachal Pradesh, Assam, Bengal, Sikkim, 600-1500 m, cultivated in Dehra Dun, N.W. India and Orissa; Commonly cultivated in Assam.

Phenology: This bamboo flowers of and on sporadically as well as gregariously at long intervals. Anantachote (1987) mentioned that this species flowers every year in Thailand. Regarding its gregarious flowering Gamble (1896) reported that it flowered in Dehra Dun during 1840 and 1893-94. Rowntree (1933) mentioned from Garo hills (Meghalaya) in 1933. Bahadur (1980) mentioned during 1966 and 1980 in Dehra Dun. Banik (1987) reported sporadic flowering during 1978-79 in Bangladesh. Sahoo (1991) mentioned gregarious flowering during 1989-90 from foot hills of North Bengal. Biswas (1997) reported gregarious flowering is summer 1995 at Nagaon Division, Assam and in 1996 at Nepal. Barooah (1999) and Barooah and Borthakur (2003) from Lakhimpur and Sonitpur district of Assam. It has sporadically flowered at Kathmandu Valley, Nepal in 2000, 2005 and 2006 (Poudyal 2006). Sharma (2008) reported from Sikkim. Author has observed observed its gregarious flowering during March 1986 in Gogamukh in Assam and 2016 near Hathibarkula in Dehra Dun, Uttarakhand.

Uses: Culms are graceful and well apart, smooth, strong, straight, thick walled. Useful

as rafter, and as shafts of dog, carts and ekkas.

Bambusa polymorpha Munro

Bambusa polymorpha Munro in Trans. Linn. Soc. 26 (1):98. 1868.





Where to see it in Meghalaya: Ri-Bhoi District: Umsaw Quinine, Nongladew (cultivated).



A large evergreen tufted bamboo, sometimes leaf-shedding in dry seasons. *Young shoots* brownish green; sheaths and blades pubescent on the back with blackish-white hairs; auricle biseriate, wavy, curled, ciliate with silvery cilia; margin of blade rolled inwards like cups, tip stiff, pointed. *Culms* in dense clumps, grey or grayish-green, covered with brown pubescence, white, scurfy when young, 10-25 m tall, 7-15 cm in diameter at base; *nodes* slightly larger in diameter than the internodes, aerial roots present and extended up to the 5th node in the young culms, generally 7th & 8th internodes are longest, length varying from 50 to 65 cm; no sulcate branching from the mid-culm and upwards; *branch bud* ellipsoidal, laterally slightly keeled. *Culm sheaths* green when young turning yellowish and ultimately brown at maturity, persistent, 15-20 cm long, 28-35 cm wide at the base, attenuated upwards into a rough top, lateral margins oblique, adaxial surface glabrous, abaxial surface covered with brownish to black appressed hairs; *imperfect blade* 5-10 cm long, concave, reflexed, deciduous, base cordate, tip acuminate, blackish-brown pubescene on abaxia; surface, black felted on the adaxial surface, lateral margins with bristles; *ligule* continuous with the sheath top, entire or undulate; *auricles* two, unequal, falcate, continguous with sheaths, often one pointing upwrds, the other downwards, fringed with deciduous rough bristles. *Leaves* small, linear-lanceolate, 6-20 cm long, 0.7 x

2 cm broad, base rounded to oblique, tip acuminate, adaxial surface shiny green, glabrous, sometimes with very few silvery bristles, abaxial surface whitish-green and pubescent; secondary veins 6-7 pairs; sheath thick with a ridge extending to the middle of the dorsal surface; *ligule* very thin, auricled, with deciduous bristles.

Inflorescence a much branched panicle with curving racemes of frequent heads; bearing few spikelets surrounded by brownish, glabrous, mucronate, chaffy bracts, rhachis wiry, smooth, the upper part covered with white appressed pubescence. *Spikelets* often brownish, shining, 10-12 mm long, in lower heads 5-6 number gradually decreasing upwards, somewhat pedicellate and enclosed in a long, curved, glabrous bract; *glumes* 1-3, ovate-mucronate, with 2 or 3 fertile florets, and a terminal imperfect florets, rhachilla produced, long, flattened, glabrous; *lemmas* ovate-mucronate, many nerved; *paleas* somewhat longer, lanceolate, acute at the top, keeled; keels glabrous or slightly ciliate. *Lodicules* 3, sub-orbicular, short fimbriate, 3-5 nerved, one smaller than the other two. *Anthers* purple, obtuse, somewhat apiculate. *Ovary* obovate, hairy at the top; *style* with 3 short white hairy stigmas. *Caryopsis* ovate, 5 mm long, depressed, flattened on one side, hairy above, ending in a short hairy mucro. It is still doubtful whether the flowers of *Bambusa polymorpha* are monoecious, dioecious or hermaphrodite. Munro and Camus say that they are monoecious or dioecious, whilst Gamble calls them hermaphrodite (Blatter, 1929).

Distribution: India: Cultivated at West Bengal, Madhya Pradesh, Assam, Meghalaya and Tripura. Bangladesh and Myanmar.

Phenology : *Bambusa polymorpha* flowers at long intervals and the flowering is remarkably gregarious. The sporadic flowering is uncommon. Its gregarious flowering is so far is known mostly from Myanmar. It has gregariously flowered in Pegu and Thaakyad in Myanmar during 1834, 1854-1860, 1862 and 1871. Bradely (1914) and Troup (1921). Gamble (1896) and Brandis (1906) reported from Youbin and Palwe Reserve Pyinanamans Division, Myanmar in 1928-1930. Win (1951) and Kermode (1952) reported from Priname Division, Myanmar in 1934. Outside Myanmar it has gregariously flowered in Bori Valley, Madhya Pradesh, India in 1940 (Bhote, 1952) from Bangladesh (Brandis, 1906) mentioned flowring from Sylhet. Last report is of Banik (1987) who reported its gregarious flowering from during 1981-1982 from Bangladesh. According to Blatter (1930) it flowering cycle is 55 years and according to Gaur (1987) the cycle is 35-60 years.

Uses : It is a promising source for supply of paper pulp. Other uses are as an ornamental, basket making, tool handles, chicks for door and windows. In Tripura it used formaking agarbatti sticks. According to Kadambi (1952) it is a very handsome bamboo and therefore attracts the Elephants and therefore hey damaged it badly.

Bambusa pseudopallida Majumdar

Bambusa pseudopallida Majumdar in Karthikeyan *et al.,* Fl. Ind. Enum. Mono. 275, 1989 . *Bambusa pallida* sensu P.Kumari and P.Singh Bamboos Meghalaya Pl. 13.2014 non Munro.

Local name: *Wamemang* (Garo)

Where to see it in Meghalaya: West Jaintia Hills: Amtapoh, Dawki. **South Garo Hills:** Balpakram National park. **Ri-Bhoi:** Bara Pani



A shrubby bamboo about 6 m tall covered with white powder when young *nodes* prominent, slightly rarised; branches prominent, about 10-15; middle branch thick, 1 cm in girth, side branches thin; *internode* shining deep green, upto 17 cm long, 3 cm in girth; *wall* thick at the base, upper internode the wall 1 mm thick. *Culms - sheaths* 10 – 20 cm x 6 – 13 cm, slightly attenuate upwards, truncate at top, glabrous, sometimes powdery on the back; imperfect blades longer than the culm – sheaths, 1 5 – 25 cm long, oblong – acuminate from a broad base which covers nearly the whole top of the sheath, abaxial surface appressed black hairy, adaxial surface glabrous; ligule ver short; aruicels pointed, one projecting upwards and the other downwards, with bristles. *Leaves* 10 – 31 cm x 2 – 4.5 cm, linear – lanceolate, rounded or sub – cuneate at the base, glabrous above, whitish and hirsute beneath, margins scabrous; petiole – like base 2 – 3.5 mm long; leaf – sheaths hairy when young, glabrous on maturity, striate, ending in a smooth prominent callus; auricles rounded, erect, with scattered long bristles; ligule very short, minutely dentate.



Inflorescence spicate branches with clusters of few pseudospikelets; rachis rounded, glabrous, smooth. *Spikelets* yellowish, cylindrical, acute, 2-4 cm long, 6-7 flowered with 1-3 gemmiparous glumes and terminal convolute immature flower, glabrous smooth; *empty glumes* 2-3, 5-10 mm long, ovate, acute, glabrous, smooth, margins smooth; *lemma* 2-2.5 cm long, ovate, acute, glabrous, smooth on outer surface as well on inner surface except few minute hairs at apex, faintly multinerved, shortly cross-veined on inner surface, margins smooth; *palea* shorter than lemma, spathulate, 2-keeled, 7-nerved in between keels, ciliate at keels, hairy on inner surface; *stamens* 6,8-10 mm long, blunt or somewhat acute at apex; lodicules immature c.1 mm, rest not seen.

Distribution: Assam and Meghalaya. India

Phenology: Tewari 1992; Seethalakshmi and Kumar (1998) reported the flowering of this species for the first time from Assam in 1965. However, P.Kumari and P.Singh (2014) mentioned flowering of 1965 from, Khasi hills Meghalaya. Since then there is no record of flowering. The present author could not locate flowering specimen during his survey.

Note: This species is often confused with *Bambusa pallida* Munro.

Bambusa tulda Roxb.

Bambusa tulda Roxb. (Hort. Beng. 25. 1814. *nom. nud.*) Fl. Ind. 2:193. 1824. *Dendrocalamus tulda* (Roxb.) Voigt, Hort. Suburb. Cal. 718. 1845. *Bambusa longispiculata* Gamble ex Brandis, Ind. Trees 668.1906. *Bambusa tulda* var. *longispiculata* (Gamble ex Brandis) Parker in Indian For. 55:561.1929. *B.tulda* Roxb. var. *gamblei* P.Kumari and P.Singh, Bamboos of Meghalaya 58.Pl. 17.2014.*syn.nov.*

English name: *Calcutta* cane, *East India brown bamboo*, *Bengal Bamboo*.

Local Name : *Rnai* (Khasi); *Thengrangai* (Jaintia); *Wati, Wagi , Wage* (Garo)

Where to see it in Meghalaya: It is commonly found throughout Meghalaya. **East Khasi Hills:** Sohra, Shella, Shillong, Mawiongsing. **West Khasi Hills:** Nongstoin, Polra, Shalang, Seinduli. **East Jaintia Hills:**Teluk village, Dkhiai, Umkiang. **West Jaintia Hills:** Pasadwar. **East Garo Hills:** Rongjeng, Darugre, Nengkhra, Bonsamgre. **West Garo Hills:** Takwakgr, Rumbadgre, Machurigre, Rangkhon. **South West Garo Hills:** Damalgre, Dawagre. **Mawkyrwat district:** Mawranglang. **Ri-Bhoi district:** Umran, Umling.





An evergreen or deciduous, caespitose, arboreous bamboo. *Young shoots*, yellowish-green, sparsely pubescent with black hairs; *blades* imbricating, powdery above, 5-10 cm in diameter (varying with the localities). Culms green when young, glaucous and sparsely pubescent, 6-20 m tall; *nodes* slightly swollen; *internodes* 20-70 cm long, ringed, with white below the nodes, 5th & 6th generally the longest; *wall* thin, 0.7-1.25 cm; *branches* many from nearly all nodes, lower branches leafless, rigid, horizontal; *branch buds* ovate, about 2 cm long, 2-keeled, slightly ciliate along the keels. *Culm sheaths* proper 15-32 cm long, 25-34 cm broad at the base, smooth or covered with appressed white or brown hairs, often white-powdery within, slightly attenuate upwards and rounded or triangularly truncate at the top; *imperfect blade* 5-10 cm long, broadly triangular, reniform or cordate, cuspidate, erect, hairy within, bases decurrent contiguous into rounded, large, long-fringed, unequal auricles, or a wavy narrow-fringed band along the upper edge of the sheath; *ligule* continuous at the top of the sheath, with entire margin. *Leaves* linear-oblong or lanceolate, rounded or cordate at the base, 6-33 cm long, 5-6 cm broad, acuminate, both the surfaces glabrous, but puberlous along the midrib, scabrous on the margin; main vein narrow, secondary





veins 6-24, intermediate 7-8, pellucid glands faint, scanty; *sheath* striate, glabrous, ending in a smooth callus and oblong rounded auricles which are fringed with long brownish bristles; *ligule* narrow.



Inflorescence variable, leafless panicle but sometimes very short spicate branches bearing interrupted clusters of few (1-5) usually fertile spikelets. *Spikelets* cylindric at first then a little compressed, 2.5-7.5 cm long, 7-12 florets, often hirsute at the top, 1-2 empty bracts at the base, with several *glumes;* lower 1-2 and upper 2-3-florets imperfect, male or female; central florets hermaphrodite; *lemmas* 2.5 cm long, smooth, shining, ovate-acute or acuminate, more or less membranous at the base, sometimes minutely ciliate on the edges; *paleas* little shorter or equal to the lemmas in length, 2-keeled, keels ciliate, 5-7 nerved between the keels, rhachilla clavate, flattened, glabrous except on the ciliate tip, articulate. *Lodicules* 3, two cuneate, oblong, obliquely truncate, hyaline, about 5 nerved, upper part long-white fimbriate, the third hyaline, acute, long-fimbriate. *Stamens* 6, rarely 3 by abortion, long exserted; *anthers* purple, obtuse. *Ovary* stipitate, obovate, hairy on the tip; *style* short; *stigmas* 3, plumose. *Caryopsis* 7-8 mm long, oblong or obovate, hirsute at the top, furrowed.

Distribution: Orissa, Bengal, Assam, Arunachal Pradehs, Meghalaya, Manipur, Nagaland, Tripura, Mizoram, Madhya Pradesh and Andhra Pradesh. Bangladesh, Myanmar, Thailand and Indonesia.

Phenology : *Bambusa tulda* often flowers sporadically or in small groups, while occasional gregarious flowering also common. Troup (1921) mentioned its gregarious flowering during 1867-1868, 1872 and 1884 in Bengal; during 1876, 1886 in Chittagong (Bangladesh); during 1889 in Assam; during 1910 in Sylhet (Bangladesh); in Myanmar during 1865, 1903-1905 in Tharrawadely; during 1908 in Prome; during 1911 in Gangaw; during 1913 in Toungoo, Zigon, Rangoon; during 1914 in Southern Toungoo, Pegu, Prome, Zigon, Tharrawaddy, Rangoon, Henzada, Ya-w and during 1916 in Southern Shan states. Anon (1927) and Anon. (1929) mentioned in 1927 and 1928-29 respectively. Baruah (1930) reported from Sylhet Division, Bangladesh during 1929-30 and stated ample mature seeds were collected. Anon. (1931), Coffey (1931) and Anon (1934) mentioned from Chittagong Hill tract, Bangladesh during 1931 and 1934. It gregsriously flowered in Mizoram during 1924-28 (Parry, 1931), 1880,1884, 1928 and 1976-1976 (Mohan Ram Gopal, 1981). It gregariously flowered at Dehra Dun in 1986 (Rawat, 1987). Banik (1987) mentioned its gregarious flowering in Bangladesh during 1976-77, 1978-79, 1982-83 and 1983-1984. Gupta (1987) mentioned flowering in North Cachar hills in 1987. Doimukh near Itanagar in 1986, Arunachal Pradesh (Naithani, 1993). Bhattacharya *et al.* (2006) have reported sporadic flowering in January 2003 at Dighra, Hooghly West Bengal. In 2007-2009 author has observed its gregarious flowering at Jalukie area, Nagaland and North cachar, Assam. By wrong identification its seed were supplied by the name of

Oxytenathera parvifolia (Naithani, 2007). From the South India of the first time it has gregariously flowered from Sukumanidi area of Bhadrachalam South Forest Division of Andhra Pradesh (Naithani *et al.,* 2012). Recently it has gregariously flowered at upper Dibang Valley, Arunachal Pradesh (Naithani *et al.*,2013).

No report of flowering from Meghalaya.

Uses: Very useful for construction, basket work, mats, water and milk vessels, furniture, boat roofs, scaffoldings. In Umsaw area it is common and cost of one clum is Rs. 15/-, when it reaches Shillong its cost increases Rs.25/- per clum.

Note: Other species of *Bambusa tulda* group viz. *Bambusa nutans, B. burmanica*, *B. longispiculata* and *B. teres* are very unsatisfactory. Thus probably Majumdar (1989) has reduced *B. nutans*. *B. longispiculata* and *B. teres* under *B. tulda*. Regarding *B. teres*, Gamble in key distinguished it from *B. nutans* by the means of anthers apiculate in *B. nutans* and penicillate in *B. teres*, but in description and figures, anthers of both the species are penicillate. On above grounds Parker (1929) stated that "I suspect *B. teres* the same as *B. nutans*". Blatter (1929) also stated that Gamble's late 31. fig. 3 and 7 from Mann's *Bhaluki makal* may or may not be *B. teres*. Gamble himself was not sure as he stated "I also think that G. Mann's *Bhaluki-makal* (Assamese) collected in Sibsagar in 1889, is this species. Blatter (1929) also stated. "Everybody is allowed to express his opinion on the identity of certain species, but a figure drawn from an uncertain specimen should not be included in a plate figuring the type specimen. This can only cause confusion". Recently Bennet and Gaur (1990) have also stated that the taxonomic status of *B. teres* appears to be uncertain. The author could not find differences to distinguish *B. nutans* and *B. teres*. Therefore following Parker (1929) at present *B. teres* has been merged under *nutans*. Autho has made extensive collection of bamboos and in opinion that *B. nutans* can be treated as a form of *B. tulda*.

Bambusa vulgaris Schrader ex Wendl.

Bambusa vulgaris Schrader ex Wendl., Collect. Pl. 2:26. t. 47. 1810.

Local Name : *Baruba, Rnaii Shilot* (War Jaintia); *Wamanna* (Garo).

Where to see it in Meghalaya: Cultivated throughout. **East Khasi Hills:** Mawriang, Shella. **West Jaintia Hills:** Dawki to Pynursla, Pasadwar, Bank of Myntdu river. **West Garo Hills:** Samphalgiri-Anguri, Phulbari area. **South Garo Hills:** Gulpani area between Bagmara and Balpakram.







A moderate sized bamboo, with distant culms. *Young shoots* dark-brown to yellowish-green; *sheaths* covered with shining dark-brown hairs; *blades* erect; *yellowish-green*, *auricle* distinct. *Culms* strong, erect and arching, 15-20 m tall, 4-10 cm in diameter, bright green, glossy, mature yellowish; branching from the lower nodes, central dominant branch produced with secondary branches from the lower most nodes, each axis segmented on the lower part and the whole becoming thickened and bulbous, the secondary branches from the lowermost nodes, and so on; *nodes* larger than internodes in diameter, containing a single ovate, obtuse or obtusely acuminate bud aerial roots present upto 8th node; *internodes* 20-45 cm long, 7th and 10th generally longest; wall 9-15 mm thick;. *Culm sheaths* deciduous from the base, appressed, the lower short, the higher 30-45 cm long, more or less broadly triangular when young, often beautifully streaked with green or yellow, rounded or truncate at the top, lateral side oblique, adaxial surface glabrous, upper surface covered with appressed shining brown or black hairs, edges ciliate; *imperfect blade* somewhat triangular, acute, 10-15 cm long, upto 10 cm broad, appressed hairy on both surfaces, margins revolute, cordate at the base, decurrent on the sheath, finally ending on both sides in round, falcate, conspicuous subequal auricles which are fringed



by wavy stiff brown curved bristles; *ligule* 0.5-0.7 cm broad, dentate, sometimes long-fimbriate. *Leaves* oblong-lanceolate to linear-lanceolate, pale-green, 9-22cm long, 1-3 cm broad, base rounded or attenuate, tip acuminate, glabrous on both surfaces, hairy beneath when young, margins and adjacent nerves scabrous, petiole 0.5 cm long; main vein narrow, pale, secondary veins 6-8 pairs, intermediate 8-9, frequent, pellucid glands giving the appearance of transverse veinlets on the under surface; *sheath* striate, laxly hairy, ending in a smooth ciliate callus, with a smooth rounded auricle with few deciduous bristles; *ligule* short, ciliate.

Inflorescence large, leafy compound panicle bearing spicate branches with heads of spikelets in bracteates clusters of 3-10; the clusters larger at the nodes, rhachis rounded furrowed, scurfy, end segments hairy. *Spikelets* erect, pedicelled, 1.5-2 cm long, oblong, acute, compressed, upto 7-florets and with an imperfect floret, rhachilla glabrous, cuneate; *glumes* one or two, 6-9 mm long, 12-nerved with some transverse veinlets, ovate-acute, ciliate towards the apex; *lemmas* 8-15 mm long, 10-14 nerved and some transverse veinlets, acuminate-cuspidate, attenuate at the base, papyraceous, fimbriate towards the apex; *paleas* 7-14 mm long, bluntly acute, 2-keeled, long, ciliate on the keels faintly 3-nerved. *Lodicules* 3, hyaline, 2.6 mm long, unequal in size, two lodicules ovate-oblong, the third longer and acute, 3 nerved, long ciliate. *Stamens* exserted, orange or purple; *anthers* 6-7 mm long, narrow, blunt or apiculate, hairy at the apex. *Ovary* narrowly oblong, hairy, surmounted by a long, thin, hairy *style; stigma* 1-3, short, plumose.

Distribution: This species under known only in cultivation. Commonly cultivated at Bangladesh.

Phenology: In most of the literature it was mentioned that in many parts of the world this species has not flowered. Gamble (1896) stated that it flowered in Chittagong in 1851 and 1879, in Sri Lanka in 1863, in Culcutta Botanical Garden in 1890 and in Singapore Garden in 1892. Banik (2000) reported flowering from Bangladesh in 1979, 1980-81 and 1983-84 estimated the flowering cycle more than eighty years. Soderstrom and Ellis (1988) mentioned that the bamboo flowered in Sri Lanka, in the 1970s. On the basis of herbarium specimens deposited at Central National Herbarium, Calcutta (CAL), Sporadic nature of flowering was reported in all the reports. However, Poudyal (2006) stated its flowering 1995 at Sikkim and Nepal. Naithani *et al.* (2008) reported it flowering from Andaman and Nicobar Islands. Bhola (2006) and Bhol and Nayak (2010) reported its flowering in 2006-2007 from different parts of Orissa viz. Khunda, Puri, Ganjam, Paipur and Cattack. Das *et al.* (2017) reported sporadic flowering in December 2015 from Lathigram of Cachar district, Assam.

Uses: It is used in thatching and roofing, basket making, hedges, furniture, shoot for food, chicks for door and windows, floats, scaffolding. In Sri Lanka and Bangladesh it is a valuable species.

Bambusa vulgaris var. ***vittata*** A. & C. Riviere

Bambusa vulgaris var. ***vittata*** A. & C. Riviere, Les Bambous: 191, 1878. *Bambusa striata* Lodd. ex Lindl., Penny Cyclop. 3:357. 1835. *Bambusa vulgaris* var. *striata* (Lodd. ex Lindl.) Gamble in Ann. Roy. Bot. Gard. Cal. 7:44, 1896. *B. vulgaris* cv. *striata* Pandey & Banerjee in J. Econ. Taxon. Bot. 25(3):546, 2001.

Where to see it in Meghalaya: East Khasi Hills: Wardlake, Shillong (cultivated).



Graceful, caespitose, loosely clumped, evergreen. *Culms* 8-15 m high, 5-12 cm in diameter, glabrous, yellow with light-green stripes, shining; *nodes* slightly swollen, lower ones rooting; *internodes* 10-35 cm long; *walls* thick. *Culm sheaths* 10-18 cm long, 15-25 cm broad at base, greenish yellow when young, rounded at top and concavely truncate, striate, outer surface densely covered with thick, appressed, black-brown hairs, edges ciliate; *auricles* 2, rounded, falcate, subequal, conspicuous, continuous with the blade, ± 1.5 cm high, with pale-yellowish, wavy, 6-8 mm long, stiff bristles; *ligule* 5-8 mm broad, dentate; *imperfect blades* triangular, acute, 5-15 cm long, upto 10 cm broad at base, greenish yellow, appressed hairy within, margins revolute, base rounded and decurrent on the sheath. *Leaves* 15-32 cm long, 2-3.8 cm broad, linear-oblong or oblong-lanceolate, base obtuse and oblique, pale green, yellowish green along the veins, glabrous beneath, ending above in a long twisted scabrous point, margin scabrous, main vein narrow, secondary veins 5-7, intermediate 6-8; petiole-like base short, upto 5 mm long; *leaf-sheaths* smooth, glabrous, yellowish on maturity; *auricles* small, rounded; *ligule* short, truncate shortly ciliate.

Distribution: China, India, Japan, Philippines under cultivation. Commonly cultivated all over India as an ornamental.

Phenology: This variety has flowered in Europe in November 1873. Koshy and Harikumar (2000) mentioned flowering records from Indonesia in 1890's and 1921, Philippines in 1908, and Cuba in 1922. Koshy and Pushpangadan (1997) reported the flowering of *B.vulgaris* var. *vittata* (yellow bamboo) from India after a lapse of 100 years i.e. May 1996 from Cherthala, Alappuzha District, Kerala. It has also sporadically flowerd in 1997 at Pune (John and Nadgauda, 1997).

Uses: This variety is much sought for its ornamental value in gardens and landscape.

Bambusa vulgaris forma ***waminii*** Wen

Bambusa vulgaris forma ***waminii*** Wen in Journ. Bamb. Res. 4:16, 1985. *Bambusa vulgaris* cv. *wamin* (Brandis) McClure in Bamboos Fresh. Perspect. 162, 1966; *Bambusa wamin* Brandis ex Camus, Les Bambusees: 135. 1913; *wamin* Brandis, Indian Trees: 685, 1906. *Bambusa ventricosa* sensu Varmah & Bahadur in Ind. For. Rec. (n.s.) Bot. 6(1):2, 1980.

English Name: Buddha's Belly bamboo, Pitcher bamboo, Lota bans



Where to see it in Meghalaya: Ri-Bhoi district: Umsaw Quinine, Nongladew (Cultivated).

Medium sized, bushy, evergreen, loosely clumped, caespitose, graceful. *Culms* usually 4-8 m high, bright green, glabrous, shining, upper 1/3rd length branching; *internodes* pitcher shaped, 5-15 cm long, lower ones shorter, uniformly much swollen, upper ones longer, swollen at the basal part, gradually narrower upwards, matured pale yellowish; *nodes* constricted, branch-nodes constricted, branch-internodes swollen at the basal part. *Culm sheaths* 10-20 cm long, 15-30 cm broad at base, rounded and covered with thick, appressed, dark-brown hairs, margain ciliate; *imperfect blades* triangular, green when young, acute, 5-25 cm long, upto 11 cm broad at base, densely hairy within, glabrous or sparsely hairy beneath, lower edges ciliate; *auricles* 2, rounded, ciliate, subequal; *ligule* 3-5 mm high, dentate or sometimes entire. *Leaves* linear-lanceolate, 10-30 cm long, 1.4-3.5 cm broad, rounded or attenuate at the base, ending above in a long, twisted, scabrous point, glabrous on both surfaces, scabrous on the margins, main vein narrow, pale, secondary veins 6-8, intermediate 8-9; petiole-like base short, upto 5 mm long; *leaf-sheaths* laxly hairy, ending in a smooth callus; *auricles* falcate with a few deciduous, short bristles; *ligule* elongated, obtuse, hairy.



Distribution: Cultivated all over India, as an ornamental.

Phenology: There is no record of its flowering.

Uses: Introduced in gardens as an ornamental.

CEPHALOSTACHYUM Munro

(In Greek *kephale,* a head and *stachys,* spike ; referring to the inflorescence. e.g. *C.pergracile*)

Cephalostachyum capitatum Munro

Cephalostachyum capitatum Munro in Trans. Linn. Soc. Lond. 26:139. 1868. *Schizostachyum capitatum* (Munro) Majumdar in Karthikeyan *et al*., Fl. Ind. Enum. Monocot. 281. 1989. *Schizostachyum munroi* Kumar & Singh in J. Ind. Bot. Soc. 701. 423. 1991.

Local Name : *Ternap,Sylli* (Khasi), *Syllih* (Jaintia), *Wati* (Garo)

Where to see it in Meghalaya: East Khasi Hills: Mawsynram, Mawkajem, Shillong Dawki road, Sohra, Syntung, Mawsmai, Pynursla. **East Jaintia Hills:** Shumpong Road and Jarin Road. **West Jaintia Hills:** Lumshnong and Mynkaimanpyt village. **West Garo Hills:** Tura.





A tall tufty or sub-arborescent, semi-scandent bamboo. *Culms* 4-10 cm long, green or yellow, pendulous over the branches of trees; *nodes* not prominent; *internodes often* 1 m long, 2.5-3 cm in diameter; *wall* 5-8 mm thick. *Culm sheaths* 15-30 cm long, 5-7.5 cm broad, somewhat thin, papyraceous towards the top on young culms, covered on the back with an adpressed, pale-brown pubescence, truncate at the top of long sheaths, the shorter lower ones rounded with concave sinus; *imperfect blade* long, erect or recurved, covered with white hairs, rounded at the base and decurrent into two small *auricles* which are sometimes fringed; *ligule* narrow, serrate. *Leaves* 10-20 cm long, 2.5-5 cm broad, pale-green, whitish beneath, ovate-lanceolate, rounded unequally at the base into a short petiole, prolonged at the top into a twisted scabrous, setaceous tip, glabrous on both surfaces, margins scabrid; main vein prominent, pale, secondary veins 4-10 pairs, inconspicuous, intermediate 6-7 without regular transverse veinlets, but distinct pellucid dots which have the appearance of oblique transverse veinlets; *sheath* glabrous, shining, fimbriate in the throat with long caducous hairs; *ligule* short.

Inflorescence dense, globular, terminal or axillary, brownish head, 2-3.75 cm in diameter. *Sterile spikelets* numerous, hidden by shining scarious scales which are often keeled on the back; *fertile spikelets* 1.5-2 cm long, few, with 1-3 sterile florets at the base; *glumes* 2,



ovate, glabrous at the top or slightly pubescent, with anastomosing nerves, apex ending in a scabrous awn; *lemmas* of the fertile florets similar in shape but with a shorter awn; *paleas* as long as the lemmas, convolute, thin, conspicuously nerved both longitudinally and transversely, 2-keeled, the keels close together and hairy between, shortly hairy and mucronate at the apex. *Lodicules* 3, oblong-lanceolate, nerved, obtuse attenuate and ciliate at the tip. *Stamens* 6, exserted; filaments long; *anthers* emarginate at the apex. *Ovary* ovoid, furrowed, glabrous, attenuate into a twisted *style; stigmas* 2, hairy. *Caryopsis* chestnut-brown, smooth, shining, depressed, surmounted by the remains of the style.

Distribution: Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim. Bhutan.

Phenology: This species seems to flower at very frequent intervals, Gamble (1896) stated, "Perhaps the real reason is that like *Dendrocalamus strictus*, it flowers sporadically and then now and again, happened in my own observation in 1874, when large tract in the Chel and Neora valleys in Brit. Bhutan covered with this species died off and became the scence of a great conflagration in the following year". According to him it flowered during 1848?, 1866, 1869, 1874, 1878, 1892 in Sikkim and during 1830, 1835, 1850, 1871-72 in Khasi hills Meghalaya. Ed. (1881) mentioned that during 1874-75 it flowered throughout in Sikkim hills and died of. Cowan and Cowan (1929) mentioned its flowering in Sikkim in 1923. Perry (1931) mentioned flowering from Mizoram during 1920-1921. P.Kumari and P.Singh (2014) stated that no records of its flowering are available after 1942. However this species was collected by Soderstrom (herbarium no. 2602), on 17th November, 1978 from Cherrapunjee (Sohra). On his herbarium label he mentioned that "The plants must have flowered 1-2 years ago as well as all culms are dead and rooting, as are the capitate inflorescence borne singly on every branch. Seedlings found with fruit still attached". This indicates that it has flowered in Meghalaya during 1976-77. (Naithani, 1993). In the year 2005-2006 ut has gregariously flowered in Zeropoint, Arunachal Pradesh, Bhalukpong area in West Kameng district to Seppa in East Kameny district (Taj *et al.*, 2009). After that in Arunachal Pradesh it has gregariously flowered in 2011-12 at Khupi Range and 10 km after Zero point to Tamen on Zerom-Daparijo road, Lower Subansiri district. All the culms were found dead. (Naithani *et al.,* 2013).



Uses: Making bows and arrows.

Cephalostachyum mannii (Gamble) Stapleton & Li

Cephalostachyum mannii (Gamble) Stapleton & Li in Kew Bull. 52(3) : 699. 1997 ; Naithani and Kandwal in *Indian Forester* 140(12) : 1257-1259, 2014. *Neomicrocalamus mannii* (Gamble) Majumdar in Karthikeyan *et al.* Fl. Ind. Enum. Monocot. 279. 1989; Naithani in Indian For.120:269.1994. *Racemobambos mannii* (Gamble) Campbell, Note. Sino-Himal. Bamboo Speci. 23. 1988. *Arundinaria mannii* Gamble in Ann. Roy. Bot. Gard. Cal. 7:26. 1896.

Local Name : *Bneng* (Jaintia)



Where to see it in Meghalaya: West Jaintia Hills: This very rare species is only found only in **East Jaintia Hills:** Amkshar (Umlyngphung).

A slender, graceful, tufted, climbing bamboo. *Culms* 10 m tall, solid, having no cavity, dark green; *nodes* swollen, bearing many geniculate branches; *internodes* 70 cm - 1 m long, 1.25 -2.5 cm in girth, smooth. *Culm sheaths* 30-45 cm long, 5-7.5 cm broad, convolute, apparently persistent, hard, rough, with sparce stiff, brown appressed bristles; *imperfect blade* 22-25 cm long, linear, ending in a long setaceous point, inserted on the sheath, continuous, appressed hairy within at the base; *ligule* narrow, dentate.



Leaves 15-22.5 cm long, 17-25 mm broad, thin, papery lanceolate, rounded or attenuate at the base into a short wrinkled petiole, the tip at first thickened and scabrous, hirsute, then surmounted by a long setaceous apex, surface smooth above, except the scabrous points on the marginal veins, somewhat glaucous and sparsely rough hairy beneath, scabrid on one margin; main vein narrow, shining, secondary veins about 5 pairs, intermediate 5-6, hardly recognizable from the secondary, no transverse veinlet; *sheath* glabrous, striate, ending on one side in a round shining callus without an auricle, on the other side in a short pointed auricle with a few long stiff bristles; *ligule* small, hairy, ciliate.

Inflorescence a dense, globular, terminal head, 2-2.5 cm wide and 1-1.5 cm long densely packed, terminal, congested spike of superposed heads, consisting of many fertile spikelets among empty aristate bracts or sterile smaller spikelets. *Spikelets* elongate, 1-1.3 cm long, glabrous, 2 flowered; *lower glumes* 1.1-1.2 cm long, ovate at base, long-scabrous above on the margins, glabrous, striate, 3-nerved, mucronate; mucro 2.5 mm long; *upper glume* 7 mm long, 7 nerved, scabrous above near the margins; mucronate, mucro 3 mm long. *Lower lemma* similar to glumes 6 mm long, 7 nerved mucronate; mucro 1 mm

long. *Upper lemma* broadly ovate, obtuse, tip bifid, minutely pubescent, 7 nerved, nerves prominent, cross nerved. *Palea* slightly longer than or equal to lemma, thin, ovate-lanceolate, truncate and bifid at apex, pubescent, 2-keeled, the keels close together. *Rachilla* not produced. *Lodicules* 3, spathulate, blunt, minutely papilose above and on the sides. *Ovary narrowly ellipsoid, produced into a thick style. Caryopsis* brown, beaked.



Distribution: Uptill 1994 this bamboo was considered endemic to Jaintia hills Meghalaya. In recent past beside Meghalaya one of the author (HBN) has reported it from Arunanchal Pradesh, Nagaland and Mizoram.



Phenology: A local man in Jaintia hills informed to Mr. P. Kharbuli Range Officer (Retd.), Silviculture Division Shillong, that it gregariously flowered in Umksian Jaintia hills in 2004 and died. It has also flowered in Mizoram in 2007 and died (Bisht and Naithani (2010). A large population of this bamboo was gregariously flowered in 2012 near Shakti village on way to Palin in Kurungkumey district, Arunachal Pradesh, all the culms were found dead (Naithani, 2014).

Uses: Used for binding material in building huts.

CHIMONOBAMBUSA (Munro) Nakai

(From Greek word *chimon* = winter, and *bambusa*, the name of the genus of bamboo; development of young branches in many species of the genus late in autumn and in winter).

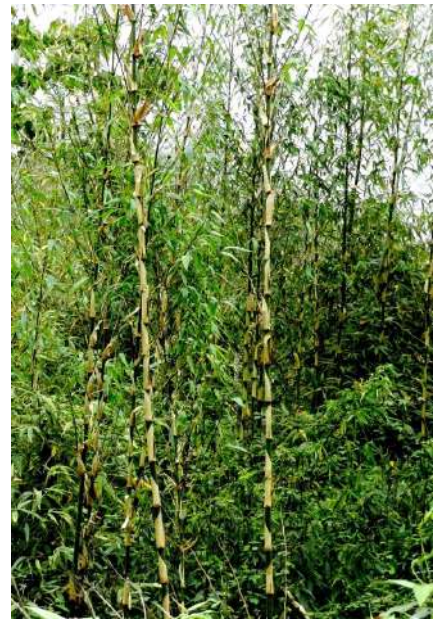
Chimonobambusa callosa (Munro) Makino

Chimonobambusa callosa (Munro) Makino in J. Arn. Arbor. 6:151. 1925. *Arundinaria callosa* Munro in Trans. Linn. Soc. Lond. 26:30. 1868; *Chimonocalamus callosus* (Munro) Hsueh & Yi in Act. Bot. Yunnan. 2:84. 1979. *Chimonobambusa armata* (Gamble) Shueh & Yi in J.Bamboo Res. 2(1):38.1838; Taj *et al*., in Bull. Arunachal Forest Res. 25(1 & 2): 15.2009. *Arundinaria armata* Gamble in Ann. Roy. Bot. Gard. Cal. 130. Pl. 119.1896.

Local name: *U Skong, U-spar, Spar* (Khasi)

Where to see it in Meghalaya: East Khasi hills: Mawphlang, Nongkrem, Shillong Peak and Mawsynram. **West Khasi Hills:** Mairang.





A shrubby bamboo. *Culms* erect, single, 4-7 m tall, greyish-green, smooth, striate when young; *nodes* prominent, armed with a circle of about 1.5 cm long, conical spines, fringed with soft brown hairs; *internodes* 15-25 cm long, 1.25-2.5 cm broad, solid at the base, the *wall* higher up being rather thin. *Culm sheaths* as long or slightly longer than internodes, covered with scattered brown hairs, loose, thin, striate, transversely veined, ciliate on the edges, gradually attenuated upwards from a hairy base to a 5 mm truncate apex; *imperfect blade* 5-25 mm long, subulate, hairy without and within, decurrent on the sheath in long-fringed, short auricles; *ligule* 2.5 mm long, fimbriate. *Leaves* 20-22 cm long, 1.7-3.5 cm broad, oblong-lanceolate, thin, unequally attenuate at the base, shortly petioled, terminating in a scabrous acuminate point, pale and pubescent beneath, scabrid-serrate on the margins; main vein prominent, shining, hairy on the upper surface, secondary veins 5-8 pairs, conspicuous, intermediate 5-6, transverse veinlets many, prominent, regular, raised beneath with many pellucid glands; *sheath* densely tawny pubescent, glabrescent, ending in a short ciliate callus, with a few stiff, curved bristles; *ligule* short, hairy, often fimbriate.



Inflorescence branched panicle ending in a leafy branchlets, the nodes of the panicles subtended by sheathing papery bracts. *Spikelets* 5-7.5 cm long, subtented by glabrous, narrow, straw-coloured bracts, 6-12-floret, rhachilla very prominent, 5 mm long, curved, flattened, glabrous; *glumes* 2, short, glabrous, ovate-acute, 1-3-nerved; *lemmas* ovate-acute, mucronate, ciliate at the apex, 3-7-nerved; *paleas* acute, 2-keeled, thickly pubescent, keels ciliate. *Lodicules* 3, ovate, faintly nerved, fimbriate, one smaller. *Stamens* slightly exserted; *anthers* short, blunt. *Ovary* ovate, glabrous; *style* short; *stigmas* 2, shortly plumose. This species is allied to *Siarundinaria griffithiana* and can be distinguished by inflorescence ending in a leafy branchlet, less hairy and thiner culm-sheaths, short imperfect blade and non hairy spices of the anthers.

Distribution: Assam, Arunachal Pradesh, Sikkim, Manipur, Meghalaya, Nagaland and Bhutan.

Phenology: Blatter (1929) mentioned only flowering in 1885 in Shillong. On the basis of one herbarium specimen gathered by Tse Ten Tashi it has flowered in Bhutan during June-July 1967. Other specimens gathered by G. Panigrahi indicate that this species gregariously flowered in Kameng District, Arunachal Pradesh in March-May 1957. In March 1986 the author (HBN) has collected specimens from sporadic flowering near Hapoli, Subansiri district, Arunachal Pradesh. P.Kumari and P.Singh (2014) mentioned its flowering in 1980 from Arunachal Pradesh without giving any source. In the year 2004-05, it has gregariously flowered Pipu-Dipu, Chayang Tajo and Sewa Lada road in Seppa, East kameng district, Arunachal Pradesh, covering an approximate area of 10 sq.km. It again gregariously flowered during May 2009 in Chayang Tajo, East Kameng district Arunachal Pradesh (Taj *et al.* 2010).

Uses: Culms used for tying the thatch of houses. In Meghalaya it is used for fencing.

Chimonobambusa quadrangularis (Frances.) Makino

Chimonobambusa quadrangularis (Frances.) Makino in Bot. Mag. Tokyo 28: 153. 1914. P. Kumari & P.Singh in Bull. Bot. Surv. India 49: 235. 2007. *Bambusa quadrangularis* Frances., in Bull. Soc. Tosc. Ort. 5: 401. 1880. *Arundinaria quadrangularis* (Frances.) Makino in Bot. Mag. Tokyo 9: 71. 1895. *Tetragonocalamus quadrangularis* (Frances.) Nakai in J. Jap. Bot. 9" 90. 1933.

Where to see it in Meghalaya: East Khasi Hills: Mr. Khongsit House, Upper Shillong (cultivated).



Much spreading, shrubby, erect bamboo. Rhizome minopodial. *Culms* 6-8 m high, 2-4 cm diameter, dark green when young turning purplish and yellowish green with age. Nodes raised with ring of spines curved downwards, loer ones rooting; internodes more or less squarish, 16-17 cm long, with spiny warts all over, thick walled, ca 1 cm, semisolid; nodal bud onion shaped; branches three equal, on upper nodes *Culm sheath* deciduous, shorter than internodes, papery, veins prominent, transverse veinlets purple-brown, margins ciliate; auricles, oral setae, and ligule absent; blade deciduous, subulate, 3-5mm, articulate. *Leaves* 2 – 3 per twig; leaf-blades linear – lanceolate, 3 – 16 cm long, 0.5 – 1.6 cm broad, subequally attenuate at base, attaining gradually into 1.5 – 2 cm long, incurved, straight or sometimes twised scabrous apex; glabrous on both surfaces, except 1 – 2 minute hairy nerves near midrib and 1 – 2 scabrid neves along ,margins on adaxial surface, margin serrate; midrib thin, prominent, glabrous, secondary veins 5 pairs, tertiary 5-7, cross veins regular, numerous. Leaf sheaths: lowest ca 4 cm long, loose striate, thin keeled, glabrous ending into narrow somewhat rounded callus, ciliate at mouth; ciliate at mouth, margins; ligule short, slightly oblique, hairy; auricles obscure, mouth end having 14 – 15, ca 6 mm long bristles.





Inflorescence racemose or paniculate, terminal ones slender, glabrous, subtended by persistent, gradually enlarged bracts. *Spikelets* (1 or) 2-4, 2-3 cm, slender; florets 2-5, basal absent to 2 rudimentary. *Glumes* 1-3, lanceolate, 4-5 mm; lemma green, lanceolate or oblong-lanceolate, subequal to palea, papery, 5-7-veined; lodicules narrowly ovate. *Anthers* 3.5-4 mm. *Stigmas* 2.

Distribution: Native Japan. There is no wind distribution of this species in India.

Note: P.Kumari and P.Singh (2007) reported its wild occurrence in Mawklot, East Khasi Hills. During bamboo survey in 2007 one of the author (HBN) visited the area but could not locate it. P.Kumari and P.Singh (2014) stated that a large area occupied by this species was cleared and burnt for jhoom cultivation. Thus now the wild occurrence of it from the area is doubtful.

CHIMONOCALAMUS Munro

Chimonocalamus griffithiana (Munro) Hsueh & Yi

Chimonocalamus griffithiana (Munro) Hsueh & Yi in Acta Bot. Yunnan 1:83. 1979. *Arundinaria griffithiana* Munro in Trans. Linn. Soc. Lond. 26:30. 1868; *A. phar* Camus, Les Bambusee 37. 1913. *Phar,* Brandis, Ind. Trees, 721. 1906. *Sinarundinaria griffithiana* (Munro) Chao & Renvoize in Kew Bull. 44:353. 1989. *Chimonobambusa griffithiana* (Munro) Nakai in J. Arn. Arbor. 6:151. 1925. *Chimonocalamus tortuosus* Hsueh & Yi in Acta. Bot. Yunnan 1:82. Pl. 8. fig. 1-8. 1979.

Local Name : *Spar rit* (Khasi); *Tyrpaid* (Jaintia); *Wamana* (Garo).

Where to see it in Meghalaya: East Khasi Hills: Mawmluh forest, Nongkhlaw, Sohra, Phangtyngur, Between Wahhiang and Mawsynram, Mawphlang, Sohra, Jatah Lakadong, Mawkyrwat, Smit, Mawkyrnot, Syntung, near Pynursla. **West Khasi Hills:** Mairang, Mawkyrwat. **West Jaintia Hills:** Syntung, Umsalang, 14 km Jowai and Jarain road, Samanong. **West Garo Hills:** Nokrek.







An erect, gregarious bamboo. *Culms*, 3-10 m tall, olive-green; *nodes* prominent, armed with a circle of up to 2 cm long conical spines, bent downwards, fringed with soft brown hairs; *internodes* 7.5-22 cm long, 2.5-5 cm in girth, solid at the base;*wall* higher up rather thin, striate, furrowed. *Culm sheaths* strite, covered with dark brown hairs, longer than the internodes, 15-30 cm long, 10-12.5 cm broad, broad at the base, where they bear a belt of thick, tawny, soft hairs, gradually and somewhat convexly attenuate upwards to a truncate top 7 mm broad; the apex furnished with rounded *auricles*, back covered thinly with scattered, stiff hairs from bulbous base, margins ciliate; *imperfect blade* 5-40 mm long, triangular at base, some-times spiral, hairy, margins



revolute; *ligule* short hairy, ciliate. *Leaves* 10-20 cm long, x 1-2.5 cm broad, linear-lanceolate, acuminate, thin, narrowed at the base into a short petiole, terminating above in long, setaceous, somewhat scabrous point, smooth above, pale below, margins smooth; main vein pale, shining, conspicuous beneth, secondary veins 4 to 5 pairs, intermediate 4 to 5, transverse veinlets conspicuous, raised; *sheath* strite, glabrous, ciliate on the edges, ending in a narrow ring with a few curved bristles; *ligule* hairy.



Inflorescence terminal panicle, surrounded with sheathing bracts, hairy at the base and ciliate on the edges. *Spikelets* 2.5-3.75 cm long, narrow with 2 empty glumes, with 4-6-florets in verticillate clusters on thin, wavy, scabrid, hairy pedicels, rhachis hairy, flattened on one side; rhachilla long, 5-7.5 mm, flattened, hairy, ciliate at the clavate top; *glumes* 2, ovate-lanceolate, mucronate, 5-7 nerved, scabrous hairy on the back; *lemmas* 12.5 mm long, lanceolate, long mucronate, scabrous hairy above, 7-nerved; *paleas* nearly as long as lemmas, bi-mucronate, 2-keeled, ciliate on the keels. *Lodicules* 3, obovate, faintly nerved, long ciliate, one shorter and narrower. *Stamens* apparently not exserted;*anthers* emarginate, crowned with a few fine long hairs. *Ovary* linear-oblong, glabrous; *style* short; *stgmas* 2, plumose.

Distribution: North Bengal, Arunachal Pradesh, Meghalaya, Mizoram, Nagaland. Bhutan, Tibet and Myanmar. Cultivated in Europe. Taj *et al.* (2009) recorded this bamboo as a new record for India from Arunachal Pradesh, which is not correct. It has been mentioned in many publications from Arunachal Pradesh where it is commonly found.

Phenology: Regarding its flowering Gamble (1896) stated that in the year 1835 its flowering plant specimen was collected by Griffith from Moflong, Khasi Hills. Blatter (1929) also mentioned flowering in 1835 from Assam (part now in Meghalaya) and in 1910 from Europe. Campbell (1988) mentioned gregarious flowering from Europe in 1894 and 1967. In Mizoram flowered in 1953 (Seethalakshmi and Kumar (1998), Sawmliana (2013). It's last flowering in 2008 from Mizoram reported by Bisht and Naithani (2010). In February-March it has gregariously flowered at Samanong, West Jaintia Hills. (Naithani and Kharsati, 2016).

Uses: Culms are used for tying the thatch of native houses also for fencing.

DENDROCALAMUS Nees

(Greek word *dendron*, tree; *klamos*, reed, tree-like reeds).

Dendrocalamus giganteus Munro

Dendrocalamus giganteus Munro in Trans. Linn. Soc. London. 26: 150. 1868. *Sinocalamus giganteus* (Munro) Camus inn Rev. Bot. Appl. 29: 559. 1949. *Bambusa gigantean* Wall. Cat. Bot. Gard. Cal. 79. 1814. *nom. nud.*

English Name: Giant bamboo

Where to see in Meghalaya: Ri-Bhoi: Bambusetum, Botanical Survey of India, Bara pani.





A large bamboo, densely caespitose. *Young* shoots cone shaped, blackish, covered with purplish hairs, blades reflexed, auricled. *Culms* 30 m tall, 18 – 25 cm in diameter, when young covered with white waxy layer, dull green when old, branched above; nodes hairy; *internodes* 30 – 40 cm long, generally 7 – 9 longest, wall 2.5 cm thick; branch buds swollen, triquetrous, ca 2.5 x 1.5 cm, not keeled; verticils of aerial roots upto 8th node. *Culm sheaths* large, 25 – 50 cm long, 40 – 60 cm broad at the base, caduceus, glabrous within, clothed with golden or brown hairs or glabrescent but rough; *imperfect blades* lanceolate, wider at the base, 15 – 35 cm long, recurved or spreading at right angles, decurrent info two narrow wavy auricles; ligule stiff, dark, bearing a short fringe. *Leaves* large, broadly lanceolate, 25 – 50 x 1 – 3.5 cm, rounded at the base, cuspidate – acuminate, ending in a twisted point, at first hairy, afterwards glabrous; main vein prominent, secondary veins 12 to 16 pairs, furnished with pellucid dots; *sheath* striate, glabrescent, hairy at the throat, with two lateral small auricles; *ligule* 3 mm high irregularly toothed.

Inflorescence large panicle with long, slender, curved branches, bearing lax heads of about ten spikelets, sometimes leafy at the top; heads upto 2.5 cm in diameter. Spikelets 12 – 20 mm long, 4 – 6 mm wide, flattened, ovate – acute, with many florestsd, the lowest



2 – 3 florets reduced to lemmas, the next 2 – 4 with lemmas and pales, sometimes female with more or less aborted stamens, the next 1 – 2 hermaphrodite, the terminal rudimentary; *glumes* ovate, mucronate, striate; *lemmas* of the female flowers 8 13 mm long, convex on the back, mucronate, many – nerved, clothed, with appressed hairs, those of the hermaphrodite florets flat on the back, shortly acute, spiny; *paleas* with long fimbriate keels, rather narrow inflexed, with finely fringed margins, short hairs all over back, 2 – 3 veins between the keels. *Stamens* 6; anthers 7 – 10 mm long, tips pointed. *Ovary* long – rostrate; style simple or bifid. *Caryopsis* 7 – 8 mm long, oblong, obtuse, hairy at the apex.

Distribution: Native of Malaya and Myanmar; frequently cultivated in North East India and Dehra Dun (Uttar Pradesh), North Bengal, Bombay (Maharashtra), Coorg (Karnnataka), Bangladesh, Peradeniya Botanic Garden, Sri Lanka. Kigomo (1988) mentioned its occurrence in Zanzibar in Amani Arboretum, North Tanzania and in Entebbe Botanic Garden, Uganda where it died after flowering.

Phenology: Gregarious flowering cycle is estimated to be 30-40 years (Dransfield and Widjaja, 1995). Gamble (1896a) stated that this species flowered in Calcutta Botanic Garden during 1860 – 1861 and again in 1888; Myanmar in 1892 and 1893. MaCmillian (1908) mentioned its flowering in Sri Lanka in 1886 and 1903 – 1907. Blatter (1931), reported form Poona (Maharashtra) in 1930. Lahri (1974) reported its sporadic flowering in 1974 from North Bengal and stated that villagers estimate the gap of flowering to be about 40 years. Bahadur (1979) mentioned its flowering in Forest Research Institute, Dehra Dun, campus in 1979. Sahni *et al.* (1996) mentioned its flowering at the Doon School's premises, Dehradun in 1994-95. Barooh (1999) mentioned its sporadic flowering from Assam in Ketalong village near Margherita and Mathurapur, Sibsagar in 1997. Jain and Mohinder Pal (2002) mentioned its sporadic flowering at Foresr Research Institute, Dehra Dun. The author observed its sporadic flowering during 1985 – 1986 in Ranger's College, Dehra Dun. The herbarium specimens deposited at DD indicates that it flowered in Dehra Dun during 1946 – 47. Author has observed its sporadic flowering only in cut culms at Car Nicobar Island in 2008. Ramanayake and Yakandawala (1998) mentioned flowering in the Kandy Islands in 1990 & 1996 with rare seeds setting.

Uses: It is used as an ornamental plant in the gardens. Each internode of the culm is made into pitcher which can contain more than half a bucket of water and therefore used as chungas. Also used for building purpose, mast of boats, flower vases, handicrafts and scaffolding etc. Young shoots are eaten. Srivastava (1990) state that fermented succulent shoots of this species are an enriched source of phytosterols. Fermented shoots can therefore be used as starting material in the production of steroidal drugs.

Dendrocalamus hamiltonii Nees et Arn. ex Munro

Dendrocalamus hamiltonii Nees et Arn. ex Munro in Trans. Linn. Soc. London. 26:151. 1868; *Bambusa monogyna* Griff. Notulae, 63. 1851 et Ic. Pl. 150. fig. 3. 1851. *non* Blanco (1837). *B. falconeri* Munro in Trans. Linn. Soc. Lond. 26:95. 1868. pp. *B. maxima* Buch.-Ham. in Wall. Cat. 5039. 1828 (*nom nud.*). *Dendrocalamus maximus* Kuntze, Rev. Gen. 773. 1891.

Local Name : *Seijheh, Siejlieh* (Khasi); *Syrtieh* (Jaintia); *Wanok, Kako* (Garo)



Where to see it in Meghalaya: East Khasi Hills: Garampani, Nongshken, Pynursla, Tangmang, Shella **West Khasi Hills:** Riwiang, Shahlang, Nongdajee, Porla, Langumshing, Nongstoin, Sienduli. **East Jaintia Hills:** Umkiang, Tluh village, Mihmyntdu. **West Jaintia Hills:** Pasadwar, Dawki. **Mawkyrwat district:** Headquarter B, Phottdhi, Mawsan Dom, Mawrangland. **East Garo Hills:** Rongjeng, Darugre, Nengkhera, Bonsawgre, Rangsakgri, Roramgri, Williamnagar. **West Garo Hills:** Takwakgr, Rombagre, Machurigre. **South West Garo Hills:** Damalgre, Okhapara, Chomgpotgri, Dawagiri. **Ri-Bhoi:** Umaram, Umling, Karbalu, Nonghymmai, large sized culms are found in Nongkhyllem Reserve Forest.



A large bamboo with caespitose culms, sometimes growing tall and erect but more often sending out its stems at an angle or curved downwards. *Young shoots* conical, *sheaths* yellowish-brown, covered with black hairs, *blades* stiff, pointed, yellowish-green, velvety pubescent on dorsal surface, ciliate along the margins. *Culms* 12-25 cm tall, 10-18 cm in diameter, dull green, covered with whitish-brown pubescence, young ones scabrid, sometimes zigzag or angled from the nodes; *nodes* marked with root scars; *internodes* 30-50 cm long, 10th to 12th internodes generally longest; *wall* 1.25 cm thick; *branches* from the base, stout; *branch buds* triquetrous, ovate. *Culm sheaths* long and stiff, deciduous at the time of branch emergence, variable in size, those of the lower part of large culms 35-45 cm long, 20 cm broad, glabrous, shining within, rough, glabrous or with scanty patches of stiff blackish-brown hairs without, truncate at the top; *imperfect blade* 8-30 cm long, 3-11 cm broad, narrow, ovate-lanceolate, sides incurved, glabrous within, closely covered with thick, black hairs within at the base; *ligule* smooth, entire. *Leaves* broadly lanceolate, 8-38 cm long, 1.5-5 cm broad, rounded at the base, ending in an acuminate, scabrous, twisted point, smooth above, rough beneath, margins serrate; main vein narrow, raised; secondary veins 6-17 pairs, prominent, intermediaate 5-7, having pellucid dots between

which form cross bars resembling transverse veinlets when dry; *sheath* thick, covered with white appressed stiff hairs, somewhat keeled; *ligule* long, oblique, truncate.



Inflorescence huge, much branched panicle with many whorls of branches, bearing half-verticillate semi-globular heads of purple florets, supported by round scarious bracts, rhachis joints 2.5 cm long, thick, fistular, scabrous and white-pruinose, heads variable, 1.75-3.25 cm in diameter. *Spikelets* purple, ovoid, depressed, 10 mm long, glabrous; *glumes* usually two, short, rounded, nerved, ciliate on the edges; *lemmas* broad, orbicular, somewhat recurved, ciliate on the edges; *paleas* of the lower florets 2-keeled, ciliate on the keels, bifid at acute apex, many nerved. *Stamens* exserted, pendulous; *anthers* purple, the connectives produced into a long, black, hairy, twisted point. *Ovary* sub-orbicular, hairy; *style* long hairy; *stigmas* 3, plumose. *Caryopsis* broadly ovoid, beaked, glabrous or hairy above.

Distribution: Bihar, Andhra Pradesh, Sikkim, North Bengal, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura in India. Nepal, Bhutan, Upper Myanmar, Bangladesh, Vietnam and China.



Phenology: This species flowers usually sporadically, so that the clumps in flower may often be found; and consequently it has been largely and often collected; at the same time like other species, it sometimes flowers gregariously. Its gregarious flowering was mentioned by Gamble (1896a) from Sikkim and Dehra Dun in 1894, Lakhimpur Division (Assam) in 1905 (Cavendish, 1905). North part of Khasi hills in 1910, 1911 and 1914; in Ruby Mines district Upper Myanmar during 1916-1917; in Myitkyna Upper Myanmar during 1916 and 1917 (Troup, 1921). Gupta (1972) stated that it gregariously flowered in Assam in 1956 (Official record) and over about 15 km stretch along the Nongpoh-Gauhati Road in 1968. Anon. (1976) recorded its gregarious flowering in 1976 in North Bengal. On its flowering from Kurseong, Mathew (1981) stated that "One flowering occurred during November, 1962 – January 1983. Gupta (1987) mentioned flowering in 1987 in North Cachar (Assam). Sahoo (1991) reported its gregarious flowering during 1989-90 from Darjeeling hills, North Bengal. The author found that its four culms growing in Forest Research Institute, Dehra Dun gregariously flowered in February-June 1992. P.Kumari and P.Singh (2014) reported its gregarious flowering in 2004 from Jaintia Hills Meghalaya. During 2008-09 it has gregariously flowered in Subansiri, Kurung Kumey and Upper Siang districts Arunachal Pradesh (Taj *et al.* 2010).

Uses: Used for walling of native huts, basket making, mats, ropes, it produces best quality edible young shoots. District council forest are supplying big size clums of *D.hamiltoni* to Hindustan paper mill, Jagi Road, Assam for paper manufacture.

Dendrocalamus hookeri Munro

Dendrocalamus hookeri Munro in Trans. Linn. Soc. Lond. 26:151. 1868. *B. globifera* Griseb. in Goett. Nachr. 72. 1868. *Melocanna* sp., Roep. ex Trin., Clav. Agrost. 105. 397. 1822.



Local Name : *Siejiong* (Khasi)

Where to see it in Meghalaya: East Khasi Hills: Upper Shillong, Sohryngkham, Sohra and Mawryngkneng. **West Khasi Hills:** Shalang, Nongstoin, Riwiang, Mairang. **West Jaintia Hills:** Jowai, Raliang, Sabah mynswang, Khlieh-tyrshi. **South West Khasi Hills:** Mawsaw domshrah, Mawranglang.



A large bamboo with caespitose stems and long curving branches. *Culms* 15-20 m tall, 10-15 cm in diameter, often naked at the base, dark green; *nodes* swollen; *internodes* 40-50 cm long, the lower sometimes rough, hairy. *Culm sheaths* large, broad at the base, narrow on the young shoots and on the upper branches, covered outside with dense black or brown hairs, glabrous inside, furnished with deciduous, small, rounded auricles covered with long stiff cilia, ciliate on the edges; *imperfect blade* 7-17 cm long, rounded at the base, triangular or long cuspidate, hairy at the top; *ligule* 4-7.5 mm long, glabrous, serrate. *Leaves* large, oblong-lanceolate, acuminate, ending in a twisted point, smooth above, rough beneath, scabrous on the margins; main vein very prominent, yellow, shining, secondary veins 8-16 pairs, conspicuous, intermediate usually 7-8; *sheath* striate, keeled, hairy below, glabrous or brown shining above, frigned on the margins; *ligule* long, long fimbriate.



Inflorescence large, compound panicle bearing at intervals 5-7.5 cm, dense glabrous heads of spikelets, 2.5 cm in diameter, rhachis dull grey-green, striate, somewhat hirsute. *Spikelets* 8-10 x 2.5 mm, ovate, acute, slightly pubescent, with 2-3 fertile florets; *glumes* 2, ovate-obtuse; *lower lemma* ovate-acute, upper many nerved, nerves anastomosing; *paleas* acute, 2-keeled, hairy on the keels; upper palea hardly keeled, ciliate on the top. *Stamens* 6, hardly exserted; *anthers* long, ending in a

penicillate point. *Ovary* narrowly ovoid, acuminate, hairy, surmounted by a hairy *style; stigmas* 2-3, plumose. *Caryopsis* hairy at the base.

Distribution: Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, North Bengal, Sikkim, Nepal.



Phenology: Gamble (1896) stated that this species flowered in Khasi hills (Meghalaya) in 1830. Gupta (1968) reported that it gregariously flowered in Khasi Hills during 1967. Later Gupta (1982) mentioned that a few culms were agaom seen in flowering in March 1982 in Jowai-Garampani Road, Meghalaya. Author in 1985 observed sporadic flowering in upper Shillong. P.Kumari and P.Singh (2014) reported sporadic flowering from Meghalaya without giving any precise locality. Parry (1931) reported the gregarious flowering of *Dendrocalamus hookeri* and *Bambusa tulda* from Mizoram during 1924-1928. The local name of *D. hookeri* given by Parry is *Ronal* or Rawnal. Infact Ronal is the local name for *Dendrocalamus longispathus* and not for *D. hookeri*. The author has also observed that *D. longispathus* is very common bamboo of Mizoram, while *D. hookeri* is uncommon. Therefore, it is presumed that *D. longispathus* might have flowered during 1924-1928 not *D. hookeri*. Surprisingly Fischer (1938) has not included such a common bamboo as *D. longispathus* from Mizoram in his account he also mentioned *Ronal* as *D. hookeri*.

Uses: Used in construction purposes.

Note: P.Kumari and P.Singh (2014) mentioned that it is planted in Garhwal. However, there is no record of its occurrence from Garhwal. Its allied species commonly planted in Garhwal is *Dendrocalamus somdevai* Naithani.

Dendrocalamus longispathus (Kurz) Kurz

Dendrocalamus longispathus (Kurz) Kurz., For. Fl. Burma 2:561. 1877.

Where to see it in Meghalaya: East Jaintia Hills: Umkiang. **East Garo Hills:** Damra

A large caespitose bamboo. *Young shoots* yellowish-green; *blade* reflexed, covered with shining blackish hairs, apex erect; *auricles* small; *ligule* silvery. *Culms* 20 m tall, upto 10 cm in diameter, glaucous-green when young, grayish-green or yellowish-green when old; *nodes* swollen; *internodes* 25-60 cm long, 7-10 cm broad, generally 6th & 7th are longest; *wall* 1 cm thick, verticels of aerial roots present in some culms upto the mid culm; *branch buds* semicircular, about 1 cm broad. *Culm sheaths* papery, green when young, brown when old, 30-50 cm long, 12-17 cm broad, covered on the back with dense, stiff, appressed brown or black hairs, more or less persistent, sides parallel till near the top where they are gradually approximate and embrace a depressed sinus on which the imperfect blade is inserted, sometimes with a round auricle on one side; *imperfect blade* 30-45 cm long, 25-36 mm broad, lanceolate-acuminate, recurved, densely hairy on the back; *ligule* broad, much serrate or often long fimbriate. *Leaves* oblong-lanceolate or linear-lanceolate, 10-30 x 2-4 cm, acuminate, shortly petiolate, glabrous above, rough or glabrescent beneath, scabrid on the edges; main vein thick, prominent, yellow-shining beneath, secondary veins 8 to 10 on either side, intermediate 6 to 7; *sheath* smooth, glabrous, with 2 small auricles; *ligule* narrow, fringed.





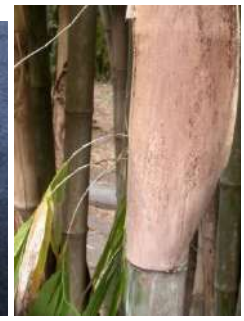


Inflorescence large panicle of interrupted spicate clusters of spikelets born at the nodes of long sinuate branches, bracteolate at the base, rhachis flexuous, flattened on alternate sides, 1.2-3.7 cm between the clusters, glaucous-green, sometimes rough. *Spikelets* 5-7 mm long, few in each head, with few to many-florets; *glumes* 2-3, obovate, blunt, joints of rhachilla short, floret 2-3, fertile; *lemmas* obovate, rounded, obtuse or truncate, cucullate, many-nerved, ciliate on the margins; *paleas* ovate-truncate, faintly 2-keeled, finely pubescent, with 2 intracarinal nerves. *Stamens* short; *anthers* yellow, ending in a

blackish mucro. *Ovary* broadly ovoid, sometimes acute; *style* long, hairy; *stigma* short, hairy. *Caryopsis* ovoid, crowned by persistent base of the style.

Distribution: Assam, Manipur, Mizoram, Tripura. Bangladesh and Myanmar.





Phenology: Gamble (1896) mentioned its gregarious flowering during 1871 and 1891 from Myanmar. Brandis (1906) mentioned flowering from Pegu (Myanmar) in 1862. Troup (1921) mentioned from Therrawaddy district in 1887; and in part of Minhla, Moka and Kadinbilin forests and elsewhere in 1887, Myanmar. Gamble (1896) mentioned gregarious flowering during 1876, 1879-1880 in Chittagong (Bangladesh). Anon. (1928) reported from Cox's Bazar division in February 1928. Anon. (1930) reported from Chittagong in 1930. It again flowered in Chittagong in 1972 and 1974 (Hasan, 1973). Banik (1987) stated that is has flowered in the Bambusetum of Chittagong in 1977-78. Gupta (1972) reported from Assam in 1968 i.e. Katakhal Reserve Forest. Rawat (1987) reported sporadic flowering in 1986 from cultivated clumps from Lalkua, Nainital. It has flowered during 2007-2008 in Teliamura subdivision under West district, Tripura (Sharma, 2010). Later Sinha and Roy (2014) indicated its symptoms of gregarious flowering by mentioning its sporadic flowering in 2014 from Babusai para of Gandhacherra subdivision of Dhalai district, Tripura. Devi *et al.* (2014) from Tripura. Hemavati *et al.* (2015) reported its gregarious flowering from Tripura in 2013-2014 from Kanchanpur, Manu and Ambassa Forest Dvisions (Dhalai district). As regards Mizoram where this bamboo is very common and locally called '*Rawnal*' there are four flowering records. Gupta (1972), Mohan Ram and Gopal (1981) and Pathak and Kumar (2000). Sawmliana (2013) mentioned flowering in 1970-71, 1974 and 2011-2013 at Lengpui. Seethalakshmi and Kumar (1998) from Kerala. Bisht and Naithani (2010) mentioned sporadic flowering in 2007 Tlungvel. Naithani (2015) reported its gregarious flowewring in 2013-14 from Longpui, W.Serzawl, Mamit, Dapchhrah, Damparengri-old Chika, Parthiantlang, Suarliap area of Mizoram. The flowering cycle estimate to be 30± 5 years. Seed ripe in April-July with diameter 1-2 mm, as per 10 gm contain 1350 seeds. In Meghalaya this species is very uncommon and only flowering record in 1947 from Garo hills has been mentioned (P. Kumari and P.Singh (2014).

Uses: Used for thatching and roofing, basket making, constructions, floats for timber and rafts, chicks for door and windows, kraft paper mat making. Young shoots are eaten.

Dendrocalamus sahnii Naithani & Bahadur

Dendrocalamus sahnii Naithani & Bahadur in Indian For. 108 (3):212. fig. 1-9. 1982.

Local Name : *Tawang* (Khasi).

Where to see it in Meghalaya: East Khasi Hills: 4th Mile, Upper Shillong and Mr. Khongsit House, Sanmer, Upper Shillong.





A thin bamboo. *Culms* upto 3 m tall, 2-3 cm in diameter, soft, pale-green, striate; *nodes* thick; *internodes* 8-20 cm long; *wall* thin. *Culm sheaths* variable in size, ca 20 cm long, 9 cm broad, glabrous, shining within, rough with scattered stiff brown hairs outside, truncate at the top; *imperfect blade* 2-2.5 cm long, ovate-lanceolate; ligule toothed or fimbriate. *Leaves* linear-lanceolate, 10-30 cm long, 2-5 cm broad, glabrous.

Inflorescence panicle, bearing at intervals of 5-9 cm dense glabrous heads of spikelets, 2.5 cm in diameter, supported by scarious bracts. *Spikelets* 0.9-1.5 cm long,0.5 cm broad; *glumes* two, ovate, keeled, nerved, ciliate on keels and margins; *lemmas* 1 or 0.8 cm, orbicular, thin, many-nerved, ciliate on margins; *paleas* 1 cm long, bifid or acute at apex, 2-keeled, ciliate on keels. *Stamens* 6; anthers yellow with a short hairy point at apex. *Ovary* conic, hairy; *style* long; *stigma* single, hairy.

Distribution: Arunachal Pradesh and Meghalaya. Tibet.

Phenology: It has flowered in 1978 at Arunachal Pradesh.

Dendrocalamus sikkimensis Gamble

Dendrocalamus sikkimensis Gamble in Hook. Ic. Pl. t. 1770. 1888.

Local Name : *Wadah* (Garo).

Where to see it in Meghalaya: East Garo Hills: Sasatgiri, Darbok, Nokrek and Simsang river banks. **South Garo Hills:** Rangmatgiri. **West Garo Hills:** Tura Peak.





A large bamboo with caespitose stems. *Youngs shoots* densely velvety felted, auricles conspicuous. *Culms* 17-22 m tall, 12-18 cm in diameter, bare at the base, branched at the top, dark green; *nodes* ringed; *internodes* 45 cm long, rough, *walls* 3.5 cm thick. *Culm sheaths* 36 cm long, 30 cm broad, broad at the top, densely covered with dark golden-brown hairs; *imperfect blades* lanceolate, often as long as the sheath, 5-7.5 cm broad, recurved, decurrent into two auricles which are fringed with long, curved, pale bristles; *ligule* glabrous, 5 mm wide, sharply serrate. *Leaves* variable in size, those of the old branches 15-25 cm long, 3.6-5 cm broad, oblong-lanceolate, thick, upper surface smooth, lower surface rough, strigosely hirsute, margins rough; main vein prominent, secondary veins not prominent, usually about 10 pairs; those of youg shoots 30 cm long, 7.5 cm broad, elliptic-acuminate; main vein rather prominent, secondary veins 12 pairs, intermediate 7; *sheath* smooth, glabrous, furnished at the edges with falcate, hairy auricles which are fringed with bristles; *ligule* short, hairy, fimbriate.



Inflorescence large panicle with stiff nodose branches, bearing large, red-brown, globose heads, usually 5 cm apart and 3-4 cm in diameter, rhachis dull brown, sparsely pubescent. *Spikelets* lanceolate, often rounded, 1.3-2 cm long; *glumes* 3-4, empty, broadly ovate, rounded, with ciliate keels; hermaphrodite florets 2-3; *lemmas* ovate-acute, glabrous, mucronate, ciliate; *paleas* of lower florets 2-keeled, densely hairy on the keels, many-nerved,

shortly bifid; upper floret sterile and reduced to a chaffy scale. *Stamens* 6, exserted. *Ovary* sub-globular, hairy; *style* short, thick, hairy; *stigma* single, club shaped, hairy. *Caryopsis* obovate-depressed, apiculate, wrinkled below, shining above with a few hairs.

Distribution: Assam, Arunachal Pradesh, Meghalaya, Mizoram, Nagaland, Sikkim Bhutan and China.

Phenology: Gamble (1896) quoted only one flowering specimen collected by R. Pantling from Niligiris in 1885. Anon. (1917) reported flowering in Kalimpong Division, North Bengal in 1917. Troup (1921) stated that its gregarious flowering occurred near Kalimpong in 1916, the seeds ripening in October. Mohan Ram and Gopal (1981) reported its sporadic flowering during 1977-1979 from Sangau area in Mizoram. Lahri (1982) mentioned that in 1982, once clump of this species in the homestead land of private individual at Kalimpong town flowered and 123 kg of seeds were obtained. Sahoo (1991) reported its gregarious flowering in the foot hills of Darjeeling Himalaya. On the basis of its flowers/seeds deposited in Carpological Museum of Forest Research Institute, Dehra Dun it flowered in August, 1921 in Kurseong Divison, North Bengal. On the basis of the study of herbarium specimens this species was collected in flowers by Phul Singh from Tangta (Bhutan) in April, 1897 and by A.T. Gage from 10 miles of Lunglei (Mizoram) in April, 1899. The former collection is deposited at (DD) and the later at (CAL). During a visit to Mizoram the local people and staff of Forest Department informed the author that this species gregariously flowered during 1978 in Buhban village near Chalfilh Mountains. Tiwari (1992) also mentioned its flowering from Mizoram in 1977-79.

Uses: For making milk and water container.

Dendrocalamus strictus (Roxb.) Nees

Dendrocalamus strictus (Roxb.) Nees in Linnaea 9:476. 1834. *Bambusa stricta* Roxb., Pl. Corom. 1:58. t. 80. 1798. *Bambusa pubescens* Lodd. in Lindl. Penny Cycl. 3:357. 1833. *Bambusa tanoea* Buch.-Ham. in Wall. Cat. 5038. A. 1828 (*nom. nud.*). *Bambusa glomerata* Royle ex Munro in Trans. Linn. Soc. Lond. 26:147. 1868. *Nastus strictus* Sm. in Rees Cycl. 24:2. 1802-20.

English name: *Male bamboo.*

Where to see it in Meghalaya: East Jaintia Hills: Umkiang. **Ri-Bhoi:** There are 25 clumps which are under cultivation in a very good condition in Umsaw, Quinine, Nongladew.



A deciduous densely tufted bamboo. *Young shoots* brown, glabrous, covered with bloom, no auricle, tip of the blade pointed. *Culms* 6-15 m tall, 2.5-7 cm in diameter, hollow in wet, solid in dry climates, glaucous green when young, dull-green or yellowish when old; *nodes* somewhat swollen; *internodes* 30-40 cm long, generally 5th and 6th are longest; sheath scar thick and uniform, remnants of sheath fibre and brown bristles present, verticels of aerial roots present up to the 6th node; *branches* from base to mid culm; *branch buds* oval, tip raised like a horn. *Culm sheaths* variable, deciduous at the time of branch emergence, 7.5-30 cm long, 10-17 cm broad, covered on the back with golden brown-stiff hairs, some times glabrous in dry climate, striate, rounded at the top, ciliate at the margins, slightly auricled; *imperfect blade* conical, 3.5-6.5 cm long, hairy; *ligule* narrow, sometimes ciliate. *Leaves* linear-lanceolate, 2.5-25 cm long, 1.5-3 cm broad, rounded at the base into a short petiole, terminating above in a sharply acuminate, twisted tip, upper surface rough or often hairy, lower surface softly hairy, margins scabrous; main vein prominent, secondary veins 3-6 pairs, intermediate 6-8, transverse veins absent, but frequently pellucid dots between veinlets present; *sheath* striate, hairy, ending in a prominent callus or short auricles with a few, wavy, deciduous cilia; *ligule* narrow, serrate.

Inflorescence large branching panicle of large, dense, glabrous spaced heads, 2.5 cm in diameter, rhachis smooth, rounded. *Spikelets* spinescent, usually hairy, the fertile mixed with many smaller, sterile ones, 7.5-12.5 mm long, with 2-3 fertile florets; *glumes* 2 or more, ovate, spinescent, many nerved; *lemmas* about 8 mm long, ovate, densely or minutely hairy towards apex, ending in a sharp 2 mm long spine; *paleas* ovate or obovate, emarginate, in lower florets, 2-keeled, ciliate on keels and hairy on surface near apex, uppermost palea not keeled often nearly glabrous, 6-9 nerved. *Stamens* long exserted;

anthers 3 mm long, yellow, shortly apiculate. *Ovary* turbinate, stalked, hairy at tip; *style* long; *stigma* one, feathery, purple. *Caryopsis* ovoid or sub-globose, 7.5 mm long, beaked.



Distribution: Throughout India. In North East India it is generally cultivated. Nepal, Bangladesh, Myanmar, Sri Lanka. Introduced in Malaya, Indonesia, Europe, China, Taiwan, Amani Arboretum in North Tanzania, Entebbe Botanic Garden, Uganda.

Phenology: *Dendrocalamus strictus* commonly flowers sporadically, in isolated clumps or in small groups, almost every year, it also flowers gregariously over large tracts at long intervals. It's gregarious flowering was mentioned by Gamble (1896) in 1878 from Garhwal and in 1880 from Oudh both in Uttar Pradesh, in Kurnool in 1887, in Golconda hills in 1890, and in North Arcot in 1891; by Troup (1921) from Uttar 1960 in Bilaspur, during 1942, 1976 in Harda, during 1930, 1965, 1985 in Jabalpur, during 1910, 1954 in North & South Khandwa, during 1900, 1921, 1946 in South Mandla, during 1930, 1967 in North Mandla, during 1924, 1960 in Raipur, during 1921, 1939, 1964 in Seoni, during 1922, 1964 in Seoni South and during 1909, 1984 in Shahdol (Umaria). Rao (1988) reported gregarious flowering from Nallamalai hills in Kurnool district, Andhra Pradesh during 1987-1988. Author has observed its gregarious flowering during 1987, 1992 in New Forest Dehra Dun and during May-June 1989 in Haripur-Chibru Road, Dehra Dun, Uttar Pradesh(now Uttarakhand). Sandhu and Jatana (1992) stated that in February, 1991 they observed gregarious flowering of *Dendrocalamus strictus* in 4 clumps growing in Indian Botanic Garden, Howrah. As this species commonly flowers sporadically, in isolated clumps or in small groups, every year. Therefore, on the basis of only 4 clumps it is difficult to say that in Howrah its flowering was gregarious. Naithani & Mohinder Pal (2001) recorded gregarious flowering during 1999-2000 at Narendra Nagar Forest Division, Tehri Garhwal, Uttarakhand. In the year 2001 it gregariously flowered in Thadugarh, Morni Range, Haryana (Naithani and Mohinder Pal, 2002).



Janzen (1976) in mentioned its flowering years from Cachar hills, Assam in 1879, 1922 and in 1966 by quoting reference number 100 i.e. Gupta (1972). Surprisingly nothing has been mentioned regarding flowering of *D. strictus* in the above mentioned article of K.K. Gupta.

Blatter (1929) mentioned its flowering outside India and Myanmar during 1907-1908 from Europe. Janzen (1976) mentioned its flowering from Taiwan (introduced) in 1922 and 1969 by quoting the reference of Wang and Chen (1971). Banik (1987) has reported gregarious flowering in Bangladesh during 1983-84.

Broun (1886) has reported an interesting event that "a clump of *Dendrocalamus strictus* flowering in 1881, sent forth new but thin shoots in 1882. These flowered again in 1885, but no new scraggy and thin shoots are pushing up in the midst of the old clump.

Pathak (1899) reported a sensational event regarding the flowering of seedlings of *Dendrocalamus strictus*. According to him in June 1894 the seeds were collected from natural forest on dry, stony, south and south-east slops of the outer hills near Kalka in Punjab; they were sown in the nursery at Pinjour in the beginning of March, 1895. In February, 1896, the plants were taken out and planted in baskets, prior to their planting into the forest. In April 1896, out of the whole lot in the basket, five plants commenced flowering and died one after another within three or four months. Later Birbal (1899), Ahmed (1937), Lauri (1937) and Ahmed (1969) also reported such event i.e. precocious flowering of the seedlings in *D. strictus*.

Another very interesting phenomena in culm cavity of *Dendrocalamus strictus* was reported by Muriel (1903). He says, "I noticed some cut bamboos (*Dendrocalamus strictus*) 10 miles north of Pyinmana with double hollows at their upper ends, and since then I have investigated further specimens. The lower portions of the culms are of the ordinary type of *Dendrocalamus strictus* found growing in fairly moist forest, but in some cases a partition is formed longitudinally some 15-20 feet from the ground. The partition appears to commence as a filament growing longitudinally between the nodes, sometimes straight and in other instance developing spirally. This is succeeded by a straight partition across the bamboo, which thickens in the higher internodes until the upper portion of the bamboo becomes quite solid. There is nothing in the external appearance of ;the bamboo to indicate the double hollow.

Krishnamurty (1978) noticed apical dichotomy in *Dendrocalamus strictus,* according to him one culm of this species has shown branching at apical portion. The two culms produced at this region are of almost equal thickness and height.

Uses: The pulp is suitable in the rayon industry, preparation of active carbon, tool handles, fishing rods, cremation coffins, cradles, ladder, bridges, scaffolding, manufacture of strong brown paper.

DREPANOSTACHYUM Keng f.

(*Drepanostachyum* Gk drepanos, sickle; stachys, spike as of an ear)

Drepanostachyum falcatum (Nees) Keng f.



Drepanostachyum falcatum (Nees) Keng f. in J. Bamboo Research 2:18. 1983. *Arundinaria falcata* Nees in Linnaea 9:478. 1834. *Sinarundinaria falcata* (Nees) Chao & Renvoize in Kew Bull. 44:357. 1989. Naithani *et al.* in Indian Forester 132(9): 1155. 2006. *Arundinaria khasiana* Munro in Trans. Linn. Soc. Lond. 26:28. 1868. *Chimonobambusa khasiana* (Munro) Nakai in J. Arn. Arbor. 6:151. 1925. *Drepanostachyum khasianum* (Munro) Keng f. in J. Bamboo Research 2:18. 1983. *Arundinaria suberecta* auct. non Munro: Gamble in Ann. Roy. Bot. Gard. Cal. 7:25. Pl. 24. 1896. *D.suberectum* (non Munro). Majumdar in Karthikeyan *et al.* in Fl. Ind.Enum. Monocot 277.1989.

Local Name : *Namlang* (Khasi & Jaintia).

Where to see it in Meghalaya: East Khasi Hills: Upper Shillong, Pyrsad, between Wahliang and Mawsynram, Lad Mawphlang near Sohra, Mawsynram, Ladmawphlang, Syntung, Laitryngew, Laittmawsiang, Pynursla, Tyrsad. **West Khasi Hills:** Markasa 26 km before Nongstoin on way to Shillong, Risiang, Mawiaban, Sohpian Porsohsat, Near Nongstoin. **West Jaintia Hills:** Muktapur. **Mawkyrwat district:** Umjarain.



A gregarious shrub with annual culms from a central rootstock. *Culms* usually 2-4 m high, rarely 6.5 m, 1-2 cm in diameter, green, grey, smooth, covered with a conspicuous whitish bloom when young, yellowish when old; *internodes* 15-30 cm long. *Culm sheaths* 30 cm long,7.5 cm broad, glabrous above, minutely scabrous hairy beneath in the upper half, ciliate on the margins, gradually and concavely attenuate upwards in the upper two-third to a narrow, truncate, ciliate, 2-4 mm broad tip; *imperfect blade* 15 mm long, 2 mm broad, subulate, recurved; *ligule* elongate, often 1 cm long, dentate. *Leaves* 7-10 cm long,0.5-0.7 cm broad, exceptionally (on young shoots 30 x 2.5 cm), linear, attenuate at base into a short, less than 2.5 mm long petiole, tapering above in to a long setaceous twisted point, scabrous above, minutely pubescent beneath when young, afterwards glabrous or with scattered soft long hairs near the midrib, margins scabrous; main vein prominent, secondary veins 2-7-pairs, but many pellucid glands, some of which give the appearance of transverse veinlets when dry; *sheath* glabrous, striate, ending in a minutely hairy ring below the petiole; *ligule* long, membranous, dentate or lacerate.



Inflorescence on separate leafless culms, consisting of falcate panicled racemes, subtented by short linear or lanceolate bracts less than 2-5 cm long. *Spikelets* 1.2-1.7 cm long, bearing two empty glumes, followed by 1 to 2 fertile florets, and a terminal rudimentary floret or free rhachilla, rhachilla cuneate, hairy at the apex; *glumes* 2, pale, the lower 7 mm long, 3-5-nerved, the upper 8 mm long, 7-9-nerved, acute, ciliate at apex; *lemmas* 1.2 cm long, sub-acute, mucronate, scabrous, 7-9-nerved, ciliate at the apex, margins black; *paleas* as long as or rather longer than lemmas, bifid, 2-keeled, 2-nerved on either side of keel, keel ciliate at apex, margins black. *Lodicules* ovate or obovate, one rather narrower, hyaline, somewhat swollen at base, 3-veined, fimbriate on the margins. *Stamens* at first hardly exserted, later protruding; filaments somewhat flattened; *anthers* bifid at the apex. *Ovary* glabrous, linear-oblong, attenuate into a short *style; stigmas* 2, plumose. *Caryopsis* linear, 12 mm long, furrowed on one side, surmounted by the base of the bifid style.

Distribution: Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Meghalaya, Mizoram. Nepal, Bhutan, Myanmar. Cultivated in Laos, Europe, South & North America and Entebbe Botanic Garden, Uganada.

Phenology: This species flowers irregularly at times, gregariously over large areas, while few clumps may be found in flower almost every year. The cycle of gregarious flowering is 28-30 years. It gregariously flowered in Shimla in 1858, in Jaunsar and Tehri Garhwal in 1886 (Broun, 1886) and in 1916 in Shimla, Mussoorie and Jaunsar (Troup, 1921; Blatter, 1929; Osmaston, 1927; Parker, 1956). Majumdar recorded gregarious flowering of this species from Khasi hills in June 1978. A report from a Deputy Commissioner-in-Charge of forests of Khasi and Jaintia hills, from Shillong on July 10th 1906, states "I have, during my tours, seen *Arundinaria khasiana* flowering on the southern slopes of the Khasi hills. The flowering is apparently general and took place from March to May of the current year" (Anon., 1906). Blatter (1929) mentioned general flowering during 1850-89 in Meghalaya, 1866-67 and 1905 in Europe, 1876 in Kullu, 1878 in Jaunsar, 1879 in N.W.Himalaya and 1908 in Kew, England. It has gregariously flowered in North-West Himalayas during 2004-2005 (Naithani *et al.,*2006). It has also flowered in Arunachal Pradesh in 2006 (Naithani *et al.,* 2007). In Mizoram, it has gregariously flowered in 1985 at Blue Mountains (Naithani, 1993). P.Kumari and P.Singh mentioned flowering in 2008 from Meghalaya. During 2008-09 it has greragiosly flowered near Sangesar (Madhuri) lake to T-Gumpa road Tawang district Arunachal Pardesh (Taj *et al.* 2010).

Uses: Used for making baskets and fishing rods and arrows.

Note: Chao and Renvoize (1989) in their revision of genus *Arundinaria* of Southeast Asia and Africa treated *Arundinaria khasiana* as a synonym of *Arundinaria falcata.* As regards *Arundinaria suberecta* they stated that plants of *A.suberecta* from Sikkim should be merged with *Arundinaria intermedia,* while the plant of Meghalaya should be kept under *Arundinaria falcata.*

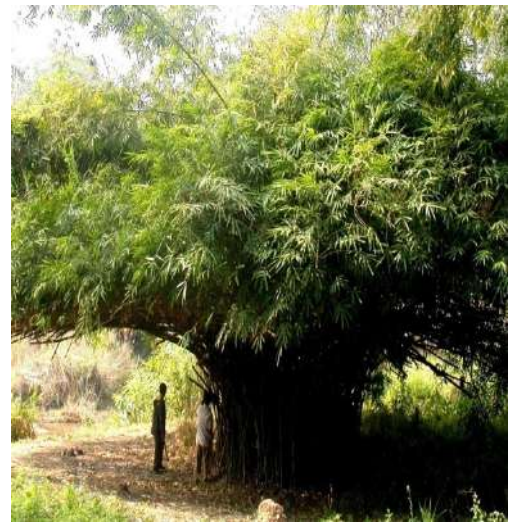
GIGANTOCHLOA Kurz ex Munro

(Greek word *gigantos*, a giant and chloa, grass. A genus of giant bamboos).

Gigantochloa albociliata (Munro) Kurz

Gigantochloa albociliata (Munro) Kurz, For. Fl. Burma 2:555. 1877; Naithani & Pal in Indian For.132: 1593.2006. *Oxytenanthera albociliata* Munro in Trans. Linn. Soc. Lond. 26:129. 1868.

Where to see it in Meghalaya: Ri-Bhoi : Cultivated at Umsaw Quinine, Nongladew.



An arborescent bamboo, evergreen or deciduous. *Young shoots* purplish-green or light green, covered with dark brown hairs; *blades reflexed*. *Culms* densely tufted, arching, 7-10 m tall, hispid at the summit; *nodes* oblique, raised; *internodes* 16-35 cm long, 1.5-2.5 cm broad; *wall* 6-8 mm thick. *Culm sheaths* 10-20 cm long, 15 cm broad, (broader than long), thick, hard, at first covered with tawny appressed hairs, afterwards smooth, folded and coriaceous at the base, ending at the truncate mouth in a nrrow, slightly auricled, naked band; *imperfect blade* oblong-lanceolate, about as long as the sheath, acuminate, broad and rounded at the base and decurrent; *ligule* 1-2.5 cm high, truncate, toothed. *Leaves* 15-20 cm long, 2-2.5 cm broad, linear-lanceolate, rounded at the base, shortly petioled, long-setaceous, glabrous above, margins scabrid; secondary veins 6-8, intermediate usually 4-5, transverse veinlets absent but frequent pellucid glands having appearance like them present on the lower surface; *sheath* smooth, striate, ending in a smooth callus and truncate edge; *ligule* rather long, faintly ciliate.



Inflorescence spreading, compound panicle, spikelets in sub-verticillate groups, placed laterally and alternately on the floriferous branches, having yellow, ciliate scales at the base. *Spikelets* 18-20 mm long, pale, narrowly cylindrical, often curved, composed of two glumes, one male floret, with (sometimes) hermaphrodite, no perfect floret at the top; *glumes* ovate-acute, white-ciliate; *lemmas* elliptic or ovate, acute or feebly emarginated, convulate, many-nerved, white-ciliate; *paleas* often much shorter, ovate-obtuse, 2-keeled, ciliate on the keels, that of the upper floret not keeled, convolute, ciliate on the keels. *Stamens* long exserted;

anthers yellowish-green, long hirsute, apiculate. *Ovary* narrowly ovoid, long-acuminate, pubescent*; style* one, long; *stigmas* 2, white. *Caryopsis* elongate, oblong-cylindrical, acuminate, beaked.

Distribution: Chhatisgarh. Bangladesh, Myanmar, Thailand, Indo-China. Cultivated at Forest Research Institute, Dehra Dun; Chessa, Arunachal Pradesh and Europe.

Phenology: According to Troup (1921) this species often flowers sporadically. Anantachote (1987) stated that this species flowers every year in Thailand. Dransfield and Widjaja (1995) stated that it flowers sporadically and gregariously. In Thailand, sporadic flowering is common and occur usually from October to December. Mature seed are available from February to April however, gregarious flowering is rare. Gamble (1896) and Blatter (1931) mentioned its sporadic flowering during 1857, 1871, 1880, 1891-92, 1900-1901 in Myanmar and in Europe during 1909. Troup (1921) mentioned its gregarious flowering from Myanmar viz. in part of the Yanaumgmyin in 1911; in Thayetmyo, the East Yoma reserve in 1912; in Toungoo in 1913; in South Toungoo, Shwegyin, Rangoon and Yaw Forest Division in 1914; in North Toungoo and Taungyin Forest Division in 1916 and in Zigon, Tharrawaddy, and West Salween Forest Division in 1917. From Chattisgarh this species was wrongly identified as *Oxytenanthera nigrociliata* (Buse) Munro, also reported new for India. There it has flowered in Oct. 1950 and Feb. 1961 (Naithani and Pal, 2006). According to Anon. (1961) and Sharma and Tomar (1964) in India it gregariously flowered in March, 1960 in North Bastar Division. An average clump consisting of about 40 culms yielded about 10-12 lbs of ripe seeds. Local enquiry revealed that the species had last seeded some 45-50 years ago. This indicate its flowering cycle 45-50 years. Sri Ram Das Baghel, Game Guard, Kanger Valley, National Park, informed the one of the author (HBN) that the species has flowered sporadically in 1995 at Kanger Valley, National Park. Dransfield and Widjaja (1995) stated that a flowering cycle of 30 years has been reported from Assam (India). Since *G.albociliata* was wrongly identified *Thyrsostachys oliveri* from Assam, therefore 30 years flowering cycle is not correct for *G.albociliata.* During June 1986 and July 1990 authors observed its sporadic flowering in Forest Research Institute, Dehra Dun.

Gigantochloa andamanica (Kurz) Kurz

Gigantochloa andamanica (Kurz) Kurz, For. Fl. Burma 2:556. 1877, Naithani in Indian For. 125:1130.1999. *Bambusa andamanica* Kurz in J. As. Soc. Beng. 39(2):88. 1870. *G. auriculata* (Kurz) Kurz, For. Fl. Burm 2:557. 1877. *Oxytenanthera nigrociliata* (Buse) Munro in Trans. Linn. Soc. Lond. 26:128. 1868. *Gigantochloa apus* sensu Majumdar in Fl. Ind. Enum. Monocot. 277. 1989. non (Bl.ex Schult.f.) Kurz (1864). P.Kumari and P.Singh, Bamboos of Meghalaya 55.2014.

Local Name : *Wasut* (Garo)

Where to see it in Meghalaya: West Garo Hills: Phulwari and Danakgri.



Young shoots green, *sheaths* covered with glossy black pubescence; *blades* erect imbricating. *Culms* 4-12 m tall, tufted, erect, glossy green, sometimes marked with longitudinal yellow stripes; *nodes* prominent; *internodes* 20-40 cm long. *Culm sheaths* 15 cm long, striate, ciliate at the margins, glabrous or covered on the back with appressed stiff brown hairs, slightly narrowed upwards, truncate at the apex; *imperfect blade* hairy within, ovate-lanceolate, upto 9 cm long, base as broad as the top of the sheath only leaving room for small, green, rounded, naked auricles; ligule narrow, entire. *Leaves* 15-30 cm long, 2.5-5 cm broad, lanceolate, rounded or tapering at base into a short petiole, ending in a subulate twisted point, somewhat scabrous above, little hirsute at first afterwards glabrous, margins scabrous; main vein prominent, secondary veins 8-12, inconspicuous; *sheath* stiff, hairy at first, afterwards smooth, terminating in two thick glossy auricles; *ligule* narrow, inconspicuous.

Inflorescence large panicle of spicate verticles, 2-5 cm apart, consisting of 3-7-spikelets, some fertile, some sterile. *Spikelets* narrow, cylindric, lanceolate, 1.5-2.5 cm long, ciliate on the argins with brown-purple hairs; the lower 3 much shortened and empty, the last two or one but one usually hermaphrodite-female, the uppermost hermaphrodite and often inclosing a terminal rudimentary floret; *glumes* broadly ovate, 3-5 mm, mucronate at apex, ciliate on margins; *lemmas* 1-1.3 cm long, lanceolate, acuminate, long mucronate, ciliate on margins, at apex with brown or purple hairs, many nerved; *paleas* 1 cm long, narrower, boat shaped, bifid at the







apex. *Anthers* purple, 5-6 mm long, apiculate, hairy at apex. *Style* simple, stiff; *stigma* white pilose. *Caryopsis* 6-8 mm long, elongate, grooved.

Distribution: Orissa, Meghalaya, Manipur, Andaman Island, Karnataka. Myanmar, Bangladesh.

Phenology: *Gigantochloa andamanica* was described by Kurz 1870. As this species was described by both vegetative and flowering material therefore, it is obvious that it has flowered before 1870. After that its flowering was mentioned by Gamble (1896) from Andaman Islands in 1875. Later under the name *Bambusa auriculata* is synonym of *G.andamanica* it has flowered in Janaury 1889 in Calcutta Botanical Garden (Naithani , 1999 & Naithani *et al.,* 2000). Banik (1987) under *Oxytenanthera nigrociliata* Munro, has mentioned that a number of the clumps of this species flowere in Publakhali area in the Chittagong Hill Tracts, Bangladesh during June 1978. On the basis of a herbarium specimen viz. Ellis & Ramamurthy no.18917 deposited at Botanical Survey of India, Western Circle Pune (MH) it has flowered in March-April 1964 at Austin I, North Andamans. On 9th March 2000 three clumps of this species were onserved in sporadic flowering with death of clumps at Shoal Bay 19, Mannarghat Range, South Andaman Forest Division. There are many sporadic flowering records are available from Andaman & Nicobar Islands. However, uptill there are two gregarious reported one from Tripura (Banik, 2004) and recently other in 2017 from Jarwa Reserve, Mahatama Gandhi Marine National Park and Shoal Bay, South Andaman, from Bakultala, Middle Andaman. Sporadic flowering occurred at Mt. Harriet (South Andaman) which may turn to be gregarious in near future. (Naithani and Lepcha, 2017).





Uses: Very useful bamboo of Andaman & Nicobar Islands used for making mats, baskets and huts.

MELOCALAMUS Benth & Hook.f.

(Greek word *Melon* apple and *Kalam* a reed, referring a reed with globular fruits).

Melocalamus compactiflorus *(*Kurz) Benth. & Hook.f.

Melocalamus compactiflorus (Kurz) Benth. & Hook.f., Gen. Pl. 3:1212.1883. *Pseudostachyum compactiflorum* Kurz in J.As. Soc. Bengal 42:252. 1873. *Dinochloa compactiflora* (Kurz) McClure in Kew Bull. 253.1937; Sawmliana, Book Mizo. Plants 58.2003.

Where to see it in Meghalaya: East Jaintia Hills: Umkiang .

An evergreen, tufted, arborescent bamboo. *Culms* 5-8 m and more tall, sometimes even upto 30 m and climbing over tall trees, grayish-green, scandent, spreading, and arching; *nodes* thickened; *internodes* 35-60 x 2.5 cm, solid, sometimes few with very narrowly hollowed towards the top, with circular band of silvery pubescence below the nodes, generally 4th is the longest; *branch buds* oval, covered with a single prophyllum, keeled towards the apex; keels ciliate. *Culm sheaths* 15 x 7.5 cm, persistent, hard, brittle, cylindrical, smooth or covered with long, white, appressed hairs, truncate at the mouth, dilated at apex; *imperfect blade* as long or longer than the sheath, recurved, long-dark reflexed, crescent shaped auricles, fringed with stiff bristles, hispidly hairy towards the base; *ligule* narrow, entire. *Leaves* 15-25 x 4-6 cm, oblong-lanceolate, rounded at the base into a short hairy petiole, margins scabrous; main vein narrow, prominent; secondary veins 8-12 pairs; intermediate 4-6; transverse veinlets absent; *sheath,* appressed white hairy when young, glabrescent, somewhat keeled, truncate at the mouth, furnished with lunate reflexed auricles, fringed with stiff, early caducuous bristles; *ligule* narrow, entire.



Inflorescence large, compound interrupted panicle of small, sub-globose heads, bearing, several fertile and many sterile spikelets, often leaf bearing; rhachis very pubescent, flexuouse, flattened on one side; *heads* 7.5-12.5 mm in diameter. *Spikelets* 2.5 mm long and as broad, glabrous, blunt or truncate, 2-cleft, with two fertile florets and one empty terminal on a produced rachilla; *glumes* 2, broadly ovate, ventricose, shortly mucronate; *lemmas* similar to glumes, often ciliate on the edges; *paleas* as long as the lemmas, boat shaped, shortly and bluntly 2-toothed, ciliate on the keels and 4-5 nerved between. *Lodicules* 3, large, ovate, blunt, long ciliate. *Stamens* 6, free; filaments short; anthers yellow, bluntly acute at the apex. *Ovary* glabrous, ovoid-gla-



brous, surmounted by a short thick style; stigmas 2 or 3, short, plumose. *Caryopsis* 2.5-3.75 in diameter, sub-globular, depressed at the apex.



Fruits globular and much like a miniature wood-apple in shape; the testa is somewhat leathery. Kurz (1877) has given a good figure of the seed. The germination of seed is almost 100 percent and they often germinate while attached to the parent plants putting out tufts of roots and a shoot prior to falling on the ground. However, this viviparous condition is not the general rule.

Phenology: Blackwell (1902) mentioned its flowring from Myanmar in 1902; Anon. (1928) reported its flowering in February, 1928 in Cox's Bazar Division, Bangladesh. Mohan Ram and Gopal (1981) mentioned its gregarious flowering in Mizoram during 1977-1979. Alam and Islam (1981) reported its gregarious flowering during 1975 and 1981 from Chittagong, Bangladesh. After scrutiny of the literature, Bahadur and Naithani (1983) have mentioned its flowering in Cachar, Assam in 1921; in Myanmar during 1926 and 1933 and in Bangladesh in 1982. In the year 2011-2012, it has gregarious flowered in Loharbond range of Cachar Forest Division of Barak Valley, Assam (Devi and Bhattacharyya, 2013 a; Das *et al.,* 2014).

Distribution: Assam, Meghalaya, Manipur, Mizoram and Tripura in India. Myanmar, Yunnan Province in China, Bangladesh, Thailand and Vietnam.

Uses: It is used for hat and basket making. In Yunan (China) and Shan (Myanmar), it is stripped in green state. The resulting fibrous layers of the internodes are very pliable and soft. These are twisted into strands and shoes/sandles are made by interlocking the strands (Blackwell, 1902). Seeds are large, edible and mealy like a chestnut (Rhind, 1945). According to Sawmliana (2003), juice of the stem is taken for influenza and also applied to scalp for curing dandruff, falling hair and baldness.

Note: Majumdar (1989) merged *Bambusa mastersii* under genus *Melocalamus* and proposed a new combination i.e. *Melocalamus mastersii.* He has also merged *M.campactiflorus* under *M.mastersii,* which is incorrect. *M.compactiflorus* has no relation with *M.mastersii.* It has its own distinct status. On the basis of morphological and anatomical studies *Bambusa mastersii* has been merged under *Teinostachyum helferi,* a species so far known only in Meghalaya and Arunachal Pradesh (Naithani, 1999). P.Kumari and P.Singh (2014) quoted reference of Malik in Bull.Bot.Surv. India 16:166.1974 under *M.compactiflorus.* However, Majumdar (1983) while describing *Melocalamus indicus* designated Malick's specimen No. 942 and his own specimen No. 73083 as type of *M.indicus.*

Melocalamus maclellandii (Munro) Naithani

Melocalamus maclellandii (Munro) Naithani in Indian For.125:1135.1999. *Bambusa maclellandii* (Munro) Kurz in J. As. Soc. Beng. 42:253. 1873. *Dinochloa maclellandii* (Munro) Kurz in J. As. Soc. Beng, 42:253. 1873.



Where to see it in Meghalaya: Ri-Bhoi district: Planted in Umsaw Quinine, Nongladew.

An evergreen, lofty, often scandent bamboo. *Young shoots* spear shaped, glabrous, sheath purplish-brown; *blade* green, reflexed. *Culms* upto 30 m long, if climbing, shorter and straggling if growing unsupported, covered by the persistent loose sheath, grey-green, small branches breaking through leathery part of sheath and growing downwards, *central bud* above the smaller one not producing a dominant branch unless culm is severed above or possibly during climbing; *wall* thin; *nodes* swollen; *internodes* 15-20 cm long, 2.5-5 cm broad, often angled when young, scabrous with brown appressed pungent hairs. Culm sheaths persistent, cylindrical, the base often dark, leathery, 15-22 cm long, 17-22cm broad, at the base, 5-7.5 cm wide at the top, covered with densely appressed, golden-brown pubescence, ending above in a narrow dark glabrous margins edging the whole of the truncate top outside the base of the imperfect blade; auricle low, laterally elongate; *imperfect blade* 15-30 cm long, 2.5-6.5 cm broad, lanceolate-acuminate, rounded at the base and decurrent on to the sheath, densely brown hairy within; *ligule* short, entire or faintly serrate. *Leaves* 15-45 vm long, 2.5-11 cm broad, broadly oblong-lanceolate, acuminate, unequal at the base, rounded into short thick petiole upto 1.25 cm long, ending in a acuminate, setaceous, twisted tip, retrorselly scabrous on one or both the margins; main vein prominent, secondary veins 10-18 pairs, intermediate about 7, transverse veinlets many, conspicuous, oblique; *sheath* striate, transverse veined, produced at the mouth into a naked, rounded auricle, keeled at the back, appressed hairy when young, afterwards glabrous; *ligule* often broad, entire or serrate.



Inflorescence large, compound interrupted panicle of small, sub-globose heads, bearing, several fertile and many sterile spikelets, often leaf bearing; rhachis very pubescent, flexuouse, flattened on one side, heads 7.5-12.5 mm in diameter. *Spikelets* 2.5 mm long and as broad, glabrous, blunt or truncate, 2-cleft, with two fertile florets and one empty terminal on a produced rhachilla; *glumes* 2, broadly ovate, ventricose,

shortly mucronate; *lemmas* similar to glumes, often ciliate on the edges; *paleas* as long as the lemmas, boat shaped, shortly and bluntly 2-toothed, ciliate on the keels and 4-5 nerved between. *Lodicules* 3, large, ovate, blunt, long ciliate. *Stamens* 6, free; filaments short; *anthers* yellow, bluntly acute at the apex. *Ovary* glabrous, ovoid-glabrous, surmounted by a short thick style; *stigmas* 2 or 3, short, plumose. *Caryopsis* 2.5-3.75 cm in diameter, sub-globular, depressed at the apex.



Distribution: Arunachal Pradesh and Assam in India. Myanmar and Bangladesh. Cultivated in Forest Research Institute, Dehra Dun. From wild author has not been able to examine any specimen of this species. It is reported here from Assam and Arunachal Pradesh on authority of Burkill (1924) and Bor (1940).

Phenology: Bahadur and Naithani (1983) wrongly identified *Melocalamus maclellandii* as *Melocalamus compactiflorus* during its gregariously flowered at Forest Research Institute, Dehradun in 1980.

MELOCANNA Trin.

(Greek word *melon*, an apple and *kanna*, a reed, means a reed like bamboo with apple like fruits).



Melocanna baccifera (Roxb.) Kurz

Melocanna baccifera (Roxb.) Kurz, Prelim. Report For. Fl. Pegu, Append. B. 1875. *Beesha baccifera* (Roxb.) Kunth in J. Phys. Chim. Hist. Nat. 95:151. 1822. *M. bambusoides* Trin. in Spreng. Neue Entdeck. 2:43. 1821.

Local Name : *Tyrlaw*, *Siejla* (Khasi); *Rthem* (Jaintia); *Watrai, Watre* (Garo); *Muli* (Assam).

Where to see it in Meghalaya: East Khasi Hills: Mawmluh, Mawlong and Mawlat, Sohra. **West Khasi Hills:** Nongshram, Shahlang. **East Garo Hills:** Nengkhra, Rongsakgiri, Bajengdoba, Jengjal, Mendal, Samphalgiri, Machurigre. **South Garo Hills:** Dalu, Gasuapara. **Ri-Bhoi Districts:** Umsaw Quinine, Nongladew.



An evergreen arborescent bamboo. *Young shoots* yellowish-brown, margins and top pink, appressed with silvery hairs, blades subulate. *Culms* up to 20 m tall, single, distant, green when young, straw coloured when old, very fine silvery bristles present in some young culms, unbranched till near the top; *nodes* marked with a thin ring; *internodes* 30-50 cm long,1.5-7.5 cm broad, at base, generally 6 to 8 longest; *wall* 5-7 mm thick; *branch buds* ellipsoidal, 2-keeled on the top. *Culm sheaths* 12.5-15 cm long, 15-30 cm broad, brittle, striate, covered with whitish appressed hairs, straight about two third of the way up, then once or twice waved, ultimately cut off straight or concavely below the imperfect blade, the edges produced upwards into rounded, often long-fringed auricles; *imperfect blade* up to 30 cm long, 2.5 cm broad, recurved, subulate-acuminate, the base decurrent into a narrow strip along the top of the sheath; *ligule* narrow, serrate. *Leaves* 14-28 cm long, 3-5 cm broad, lanceolate or oblong-lanceolate, with a long, scabrous, twisted point, rounded at the base into 1.25 cm long petiole, glabrous above, glaucescent beneath and hairy when young, scabrous on the margins; main vein prominent, secondary veins 8-12; intermediate 5-6, inconspicuous, transverse veinlets absent but regular, rather distant, pellucid glands with bars between veinlets; *sheaths* glabrous, smooth, ending in a pointed auricle which bears 10-12 stiff, long, white, deciduous bristles, margins ciliate; *ligule* very short.



Inflorescence large, compound panicle of one sided, drooping, spicate branches bearing clusters of 2-3 spikelets in the axils of short, blunt, glabrous, bracts. *Spikelets* about 1.25 cm long, glabrous, spinose; *glumes* sometimes gemmiparous, striate, lanceoate, shortly mucronate; *lemmas* similar but thinner; *paleas* glabrous, convolute, mucronate, acuminate, not keeled. *Lodicules* 2, narrow, linear-oblong, obtuse and erose, fimbriate at the top, 3-5 nerved. *Stamens* free at the base or irregularly joined; *anthers* yellow, notched at the apex. *Ovary* ovoid; *style* elongate; *stigmas* 2-4, recurved, hairy. *Caryopsis* large, 7.5-12.5 cm long and 5-7.5 cm broad, obliquely ovoid, fleshy, beak curved pericarp thick, fleshy.



Phenology: This bamboo flowers gregariously. Kurz (1876) and Stapf (1964) mentioned its flowering gap between 30-35 years. While Varmah and Bahadur (1980) stated 30-45 years. According to Gamble (1896), Troup (1921), Pearson (1920) and Blatter (1929) it gregariously flowered in Chittagong (Bangladesh), Arakan and Botanical Garden, Calcutta during 1863-1866; Garo and Khasi hills (Meghalaya) during 1889, 1892, 1900 and 1902; Sylhet (Bangladesh) during 1910-1911, Garo hills, Cachar, Sylhet and Mizoram during 1911-1912; in Arakan during 1915-1916. It flowered in West Bengal during 1912-13 (Blatter, 1929 and 1933; Anon. 1960). Flowered in Chittagong hill Division, Bangladesh in 1931 and that time hundred fruits were sold at a cost of Rs. 20/- (Anon. 1931). Dent (1946) mentioned that a patch of a couple of acres of *muli bamboo* was in flower near Dantmara in north of Chittagong division. This was the third consecutive year that a small area of *muli* flowered in this place. Nath (1968) mentioned its flowering from Assam, but Gupta (1972) under *Dendrocalamus longispathus* stated "Recent flowering of Muli bamboo reported by G.M. Nath (3) was not probably of *Melocanna bambusoides* Trin., as reported by him but of this species. The writer inspected the area where *Muli* had been reported to be in flower, during March, 1969 and found that no *Muli* was flowered but many culms of this species were in flower". Chatterjee (1960) reported the flowering in Mizoram in 1960. Moahn Ram and Gopal (1981) stated that a survey of forest records indicates that gregarious flowering has occurred in Mizoram during 1910-12 and 1958-



1959. Gupta (1988) reported its sporadic flowering in Nanadisa and Haflong, Assam in June 1988. Sharma (1992) has observed its gregarious flowering in Forest Research Institute, Dehra Dun during April-May, 1991 to May 1992. Fruit appeared after July 1991 to May 1992. According to Kurz (1876) the fruits occasionally germinate on the culms, sometimes making 15 cm growth before they drop. Vaid (1962) also mentioned this phenomenon and stated that "Some of the fruits which are clinging close to the nodes on the main clump and near the ground level are not easily disturbed by the wind". Late in the season, when there is enough of humidity in the atmosphere, these fruits get a chance of developing into a good sizeable fruit with a 6-8 inches long shoot growing out of the boarder end while still on the trees, confirming the phenomenon of vivipary in this species.

Distribution: West Bengal, Sikkim, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura in India. Bangladesh and Myanmar. Cultivated at Dehra Dun, Karnataka, Calcutta, Singapore, Guatemala, Florida, Jamaica and China.

Uses: Very useful bamboo for paper pulp, making small bridges, thatching, screens, baskets, wall of huts, umbrella sticks, chicken cages, hats.

Melocanna clarkei (Gamble ex Brandis) P.Kumari & P.Singh



Melocanna clarkei (Gamble ex Brandis) P.Kumari & P. Singh in NELUMBO 51:234-240. (2009). *Arundinaria clarkei* Gamble ex Brandis in Ind. Trees 666. 1906. *Neomicrocalamus clarkei* (Gamble ex Brandis) Majumdar in Fl. Ind. Enum. Moncot. 279.1989. *Racemobambos clarkei* (Gamble ex Brandis) Kumar in Seethalakshmi & Kumar, Bamboos India 230, 1998. *Schizostachyuym mannii* Majumdar in Karthikeyan *et al.,* Fl. Ind. Enum. Monocot. 281-282. 1989. *Bambusa khasiana* sensu Gamble in Ann. Roy. Bot. Gard. Cal. 7:39. Pl. 37. 1896 non Munro 1868.

Local Name : *Tyra war* (Khasi); *Sorim,Serim* (Jaintia);



Where to see it in Meghalaya: East Khasi Hills: Laittyra, Mawsmai. **East Jaintia Hills:** Doma river banks Umkiang, Amdoh, Badarpur, Nongkhen. **West Jaintia Hills:** From Sydai to Pasadwar, Bank of river Rymbein on way to Dawki, Leshka damsite.

Moderate sized, erect bamboo with distant culms. *Rhizome* pachymorph with 50-60 cm or longer solid necks. *Culms* 10-12 m tall, 2-3 cm in diameter, light green to yellowish green, turning grayish with age; *nodes* even, merely a line, oblique, with 1-1.5 cm broad white ring below and a thin 2-3 mm dark purplish ring above; *internodes* terete, unequal, much varying in length (5-31 cm), hollow, thin walled, wall thickness c.2 mm; bud short, ovate with ciliate appendages; *branch compliment* with 11-12 more or less subequal branches, usually from upper nodes only. *Culm-sheathes* deciduous, shorter than internodes, triangular, yellowish-brown; sheath proper 8-10 cm long, 10-12 cm broad at base, gradually attaining into 4-5 cm broad, truncate top, thin, crustaceous, rolled, faintly striate, densely appressed blackish-brown hairs on outer surface below, glabrous smooth on inner surface, margins smooth; *imperfect blade* as long as sheath proper, caducous, erect, striate, with enflated, broad, rounded base and acuminate, recurved apex, long ciliate (deciduous) at incurved margins; liqule c. 1 mm high, entire, smooth; auricles obscure. *Leaves* 5-6 per twig;leaf-blades lanceolate, 18-25 cm long, 2-3 cm broad, unequally, rounded-attenuate at base terminating somewhat acuminately into 1-1.5 cm long feathery apex with setaceous tip, glabrous on both surfaces except 1-2 scabrid nerves along one margin on adaxial surface and few hairs near base on abaxial surface, smooth at margins; mid vein thin, prominent, glabrous, secondary veins



8-10, tertiary veins 5-7, faint, not easily distinguished, few faint hair like dots are observed on abaxial surface; *pseudopetiole* 6-7 mm, swollen, buldging; leaf-sheath faintly striate, somewhat thin keeled, glabrous, ending into rounded, narrow callus, ciliate at margins first afterwards smooth; *liqule* narrow, truncate, glabrous, except few hairs near petiole attachment; auricles roundedly-elongate, somewhat pointed, bearing 5-6, c.5 mm long cilia.



Inflorescence spicate panicle on leafy branches 15-30 cm long, 10-12 drooping at culm nodes; each branch nodes bearing 2-3, 10-15 cm long branchlets; rachis striated, hirsute, somewhat flattened at one side, bearing clusters of spikelets in bracts. *Spikelets* bracteate, having lower 2-4 prophyllus and glumes with immature floret buds and terminal mature flower with hairy rachilla extension; *bracts* c.1.2 cm long, ovate-lanceolate, mucronate, pubescent on outer surface, long ciliate along margins; rachilla 1-2 mm long, flattened at one side, glabrous except very few minute cilia at apex; *empty glumes* 2 in mature floret, 5-6 mm long, ovate, acute, mucronate, 5-7 nerved, glabrous, ciliate along margins; *lemma* c.6 mm long, ovate, acute, short mucronate, 9-nerved, glabrous, minutely ciliate at apex on margins; *palea* equal or slightly longer than lemma, ovate, acute, faintly 2-keeled, 1-nerved between keels, 2-nerved on either side, glabrous entirely except few minute hairs at apex, with terminal rachilla extension hairy at apex; *stamens* 6, c.4 mm long, exserted, blunt at purplish apex, ovary c. 0.5 mm, glabrous, continuing into short style, which soon divides into 3, hairy stigmas; *lodicules* 3, c.3 mm, oblong, ovate, white fimbriate at top, hyaline, transparent, becoming somewhat fleshy afterwards; *fruits* fleshy, pyriform, 2-3 cm across, 2-4 cm long, with 5-10 mm long, pointed, slightly curved beak.

Phenology: According to P.Kumari and P.Singh (2014) it has flowered gregariously in March-April 2004 in near Umkiang East Jaintia hills. Local people believed that it flower after a gap of 30-35 years.

Distribution: Endemic to North-east India. Assam, Manipur, Meghalaya and Mizoram in India.

Uses: Used in building huts and basket work in general.

NEOMICROCALAMUS Keng f.

Neomicrocalamus prainii (Gamble) Keng



Neomicrocalamus prainii (Gamble) Keng f. & Wen in J. Bamboo Research 2:38.1983. *Microcalamus prainii* Gamble in J. As. Soc. Beng. 59(2):207. Pl. 7. 1890. *Racemobambos prainii* (Gamble) Keng.f. & Wen in J. Bamboo Research 5(2):13. 1986. *Microcalamus prainii* Gamble in J. As. Soc. Beng. 59(2):207. Pl. 7. 1890. *Arundinaria prainii* (Gamble) Gamble in Ann. Roy. Bot. Gard. Cal. 7:21. Pl. 19. 1896. *Thamnocalamus prainii* (Gamble) Camus, Les Bambusees 54. 1913.

Local Name : U-*Spit* (Khasi); *Tyrpit* (Jaintia)

Where to see it in Meghalaya: East Khasi Hills: Laittyrra, Mawsynram, Sohrarim forest, Umiam valley, Sohra, Pynursla and Laitkyrang. **West Jaintia Hills:** Muktapur.



A small, wiry, climbing bamboo. *Culms* thin, slender, smooth, green or yellowish, curving upto 10 m long; *nodes* swollen in a well marked ring; *internodes* usually 20-22 cm long, 5-7.5 mm in girth; *wall* thick, often quite solid; branches fasciculate at nodes. *Culm sheaths* thin, 2-15 cm long, 1-2 cm broad, somewhat scabrous above, convexly attenuate in the upper half to a narrow edge; *imperfect blade* 2.5-5 mm long, subulate; *ligule* short, rounded. *Leaves* thin, 5-10 cm long, 7.5-17.5 mm broad, rounded at the base into a short petiole terminating above in a long curved, setaceous point, scabrid on margins; main vein scarcely prominent, secondary veins 2-3 pairs, intermediate 4-7, without transverse veinlets; *sheath* striate, smooth; *ligule* rounded, blunt.



Inflorescence loose panicle originating in axils of bracts on leafy branches with 5-10 or more, small, ca 15 cm long and one dominating ca 50 cm long branches from culm node; rachis flattened, thin, glabrous, smooth, striate. *Spikelets* distant, on ca 1 cm long pedicels, 1.5-3 cm long, generally 4-5 flowered; rachilla 4-5 mm long, flattened on one side, striate, glabrous; empty glumes 2, lower ca 6 mm, upper ca 8 mm long, scabrous at top on outer surface, faintly cross veined and minute hairy above on inner surface, 5-7 nerved; lemma ca 8 mm long, 5 mm broad, ovate-acuminate, gla-



brous except minutely hairy at top on both surfaces, margins ciliate at apex, 9-nerved; palea ovate-acute, as long as lemma, 2-keeled, minutely ciliate on keels, densely minute hairy and faintly 2-nerved in between keels; lodicules 3, hyaline, ca 2 mm long, two similar, broad obovate, third acute-lanceolate, thin, faintly 3-5 nerved, margin smooth; stamen 6, ca 4 mm long, hardly exserted, somewhat curved, bluntly apiculate; ovary ca 1.5 mm long, oblong, ciliate above.

Distribution: Endemic to Northeast India, Meghalaya, Nagaland, Manipur and Arunachal Pradesh. India.

Phenology: *Neomicrocalamus prainii* is so far known only by single flowering collections i.e. Prain in 1886 from Nagaland. On 10 November, 1986 the local people informed the author (HBN) that this species gregariously flowered in Djaphu valley in Nagaland during 1983. Taj *et al.* (2009) reported its gregarious flowering in October 2008 at Hayuliang to Hawai in Anjaw district and in April 2009 in Mayodia to Anani in Lower Dibang Valley, Arunachal Pradesh. In the year 2011-2012 in Lower Dibang Valley almost all the clumps of this species was observed in gregarious flowering at 55 miles and in between Italin and Anani. (Naithani *et al.,* 2013). Mr. P.Kharbuli (Retd.) Range Officer, Silviculture Division, Shillong informed to the author (HBN) that in the year 2012 it was gregariously flowered and died at Cherrapunji (Sohra), Meghalaya.

PHYLLOSTACHYS Sieb. & Zucc.

(From the Greek and *phyllos* = leaf, an *stachys*, spike, because of the apical leaves covering the spikelets with normally developed lamina).

Phyllostachys mannii Gamble

Phyllostachys mannii Gamble in Ann. Roy. Bot. Gard. Cal. 7:28. Pl. 28. 1896. *P. decora* McClure in J. Arn. Arbor. 37:182. 1956. *P. bambusoides* auct. non Sieb. & Zucc., Munro in Trans. Linn. Soc. Lond. 26:36. 1868; Gamble 7:27. 1896, quoad *Griffith* 6728.

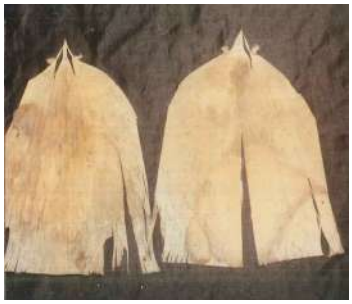


Local Name : *Siej Naga* (Khasi).

Where to see it in Meghalaya: It is very commonly planted in and around Shillong and West Khasi Hills.

A caespitose bamboo. *Culms* 5-6 m tall, variable in girth, *nodes* prominent; *internodes* 20 cm long, 2.5-3 cm in girth, green or yellow, flattened on one side. *Culm sheaths* 20-22 cm long, 2.5-5 cm broad, papery, straw-coloured, rounded at the top and truncate, extended at the base of the blade into two conspicuous fimbriate, caducous, curved auricles; *imperfect blade* 5-7.5 cm long, recurved, narrow, subulate, decurrent on the sheath; ligule broad, long pectinate. *Leaves* in pairs on branches, thick, 10-12.5 cm long, 1.25-2 cm broad, rounded at the top, smooth and glabrous on both surfaces except for a few white hairs near the midrib beneath, shining, secondary veins 5 pairs, intermediate 7-8, transverse veinlets extremely numerous and finely tessellate; *sheath* loose, glabrous, smooth, straw-coloured, ending in a narrow callus *ligule* short.





Inflorescence unknown.

Distribution: Assam, Arunachal Pradesh, Nagaland and Meghalaya in India. Myanmar and China. Cultivated in England.

Phenology : This species uptill now is not known by flowers.

Uses: Commonly used for fencing.

Phyllostachys nigra (Lodd. ex Lindl.) Munro

Phyllostachys nigra (Lodd. ex Lindl.) Munro in Trans. Linn. Soc. Lond. 26:38. 1868. *Bambusa nigra* Lodd. ex Lindl. In Penny. Cyclop. 3:357. 1835.

Where to see it in Meghalaya: East Khasi Hills: Planted at Ward's Lake, Shillong.

Rhizomes long creeping, pale-yellow at first later becoming purplish-black. *Culms* 3-6 m tall, 2-4 cm in dia, olive-green at first, becoming purplish in the second year, ultimately purplish-black, erect, slightly scaberulous, soon glabrescent; *nodes* with 2-prominent rings; *internodes* 10-15 cm long with a powdery band below nodes; *wall* 4-6 mm thick. *Culm sheaths* yellowish-green to light orange-yellow when young, ciliate; *auricles* ciliate, conspicuous with scabrous bristles; *imperfect blade* short, reflexed, lanceolate; *ligule* 2-2.5 mm height, ciliate. *Leaves* 2-3 on twigs, 5-10 cm long, 8-12 mm broad, lanceolate, chartaceous, acuminate, glaucescent, pubescent near base beneath, slightly hairy along nerves, tessellate, margins minutely spinulose; *sheath* auricles lacking, substituted with none to few bristles; *ligule* membranous, 0.5 mm high, ciliate.

Distribution: Native of China. Cultivated in Taiwan, Japan, India, Korea, Europe, America, U.S.S.R., Algeria, Marocco, Philippines, Indonesia, Australia.

Phenology: It flowered in Europe several times, the last flowering between 1932 and 1935.

Uses: As an ornamental in hill stations.

PLEIOBLASTUS Nakai

Pleioblastus viride-striatus (Regel.) Makino

Pleioblastus viride-striatus (Regel.) Makino in J. Jap. Bot. 3.11. 1926.

Where to see it in Meghalaya: East Khasi Hills: Ward's Lake Shillong.



Erect, shrubby, spreading or tufted bamboo, with interwoven running rhizome, rooting at each nodes. *Culms* ca 1 m high or spreading on ground, thin, hardly 2-4 mm in diameter, yellowish; nodes swollen, dark ringed below; intrnodes 2-12 cm long, glabrous. *Culm-sheath* not seen. *Leaves* 9-10 per twig; leaf-blades 3-13 cm long, 0.8-2 cm broad, linear-lanceolate, striated green and yellow, unequally rounded at base, attaning gradually one side and cuspidately from another into a short, twisted, curved scabrous apex, hairy on both surfaces earlier, afterwards glabrous, margin serrate, long ciliate near base; midrib prominently thick, hairy, secondary veins 5-6 pairs, tertiary 7, cross veins regular, numerous; pseudopetiole ca 2 mm long, hairy; leaf-sheath lowest 3-4 cm long, hairy, afterwards glabrous, striate, cross veined, ending into narrow, rounded, glabrous callus, margins ciliate; ligule short, hairy; auricles short, rounded, with 4-5, ca 4 mm long, straight bristles.

Distribution: China and Japan.

Uses: As an ornamental in hill stations.

PSEUDOSASA Nakai

(From the Greek words *pseudos* = false, and *Sasa*, the name of the genus of bamboo under which the species of *Pseudosasa* were earlier included).



Pseudosasa japonica (Sieb. & Zucc. ex Steud.) Makino

Pseudosasa japonica (Sieb. & Zucc. ex Steud.) Makino ex Nakai in J. Arn. Arbor. 6:150. 1925. *Arundinaria japonica* Sieb. & Zucc. ex Steud., Syn. Pl. Glum. 1(6):334. 1855. *Sasa japonica* (Sieb. & Zucc. ex Steud.) Makino in Bot. Mag. Tokyo 26:13. fig. 2. 1912. *Yadkiya japonica* (Sieb. & Zucc. ex Steud.) Makino in J. Jap. Bot. 6(7):16. 1929.

Where to see it in Meghalaya: East Khasi Hills: Planted at Ward's Lake, Shillong.

Culms 2-5 m tall, hollow; *nodes* hardly prominent; *internodes* 5-15 mm in diameter, glabrous, green, farinose below the nodes, branches solitary on upper part of the culm. *Culm sheaths* persistent, elongate, hispid. *Leaves* 8-30 cm long, 1-4.5 cm broad, narrowly-lanceolate, glabrous, long-acuminate, acute at base, deep green above; *sheath* glabrous, sometimes purplish, the oral setae often absent. *Inflorescence* panicle, 8-15 cm long. *Spikelets* green or purple with 5-10-florets; *glumes* 5-10 mm long, acuminate; *lemmas* 10-12 mm long, narrowly ovate, acute, scaberulous above; *paleas* 8-12 mm long, keeled, ciliate on the keels. *Stamens* 3 or 4; filaments glabrous; *anthers* pale-yellow or moderately purplish. *Ovary* glabrous; *style* short, glabrous; *stigmas* 3, elongate, sub-plumose.

Distribution: Native of Japan. Cultivated in China, Taiwan, Korea, Indonesia, India, Algeria, France, England and USSR.

Phenology: It flowered in England during 1872 and 1874 and in Japan 1880, 1886 and 1898.

Uses: Cultivated as an ornamental in gardens.

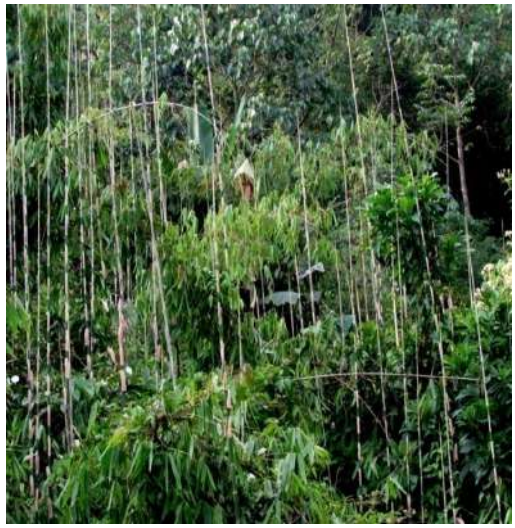
PSEUDOSTACHYUM Munro

(Greek word *Schistos,* cleft, divided; *Stachys,* ear or corn; referring to the spaced grouping of the spikelets)

Pseudostachyum polymorphum Munro

Pseudostachyum polymorphum Munro in Trans. Linn. Soc. Lond. 26:142. tab. 4. 1868. *Schizostachyum polymorphum* (Munro) Majumdar in Karthikeyan *et al*., Fl. Ind. Enum. Monocot. 282. 1989.

Local Name : *Tyra* (Khasi & Jaintia); *Wachal* (Garo)





Where to see it in Meghalaya: East Khasi Hills: Mawkyrnot, Phlangtyngur. **West Khasi Hills:** Polra, around Risiang. **West Jaintia Hills:** Leshka. **East Garo Hills:** Darugre and Siju. **South Garo Hills:** Balpakram National park. **Ri-Bhoi:** Umiam Main Dam and Nongkynrih-neng thyllong area of Nongkhyllem Reserve.

A large shrubby or semi-arborescent bamboo with single culm from a long creeping, jointed rhizome. *Culms* 7 m tall, often supported by adjoining trees, and so appears scandent; *wall* 5 mm thick; *nodes* not swollen; *internodes* 22 cm long, 3.5 cm broad, glaucous at first, afterwards dark green, whitish below the nodes, somewhat scabrous. *Culm sheaths* shorter than internodes, triangular -truncate in outline, very shortly auricled with a tuft of short bristles, covered out side with appressed dark brown hairs; *imperfect blade* caducous, long-acuminate in young culms, shorter and triangular on older ones, striate and furnished with purplish transverse nerves; *ligule* short, slightly dentate. *Leaves* oblong-lanceolate, 10-35 cm long, 2.5-5 cm broad, unequally rounded at the base into a short petiole, attenuate at the top into a long twisted point, surfaces smooth, magins scabrid; main vein pale, conspicuous, secondary veins 7-11, intermediate 5-6, transverse veinlets many, oblique; *sheath* faintly white-pubescent, glabrescent; *ligule* short.



Inflorescence very large leafy panicle, composed of branches fascicled at the nodes, pendulous or curved. *Spikelets* 5 mm long with one fertile floret, rhachilla produced bearing glumes or an incomplete floret; *glume* one, broad, mucronate, 7-nerved; *lemmas* similar to the glume, finely ciliate above, *paleas* thin, much convolute, 2-keeled, ciliate on the keels. *Lodicules 3-5,* usually 4, large, acute, rounded or truncate at apex, ciliate, persistent. *Stamens* 6, free; filaments short; *anthers* apiculate. *Ovary* narrow, linear-oblong, ending in a rigid *style; stigmas* 2, hairy. *Caryopsis* globose-depressed, surmounted by the base of the style; pericarp crustaceous.

In flowers this species is attacked by the insects and as such the inflorescence is very often found mal-formed.



Distribution: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and North Bengal, Andhra Pradesh, Andaman Islands. Myanmar and Bhutan and Yunnan Province of China.

Phenology: It generally flowers sporadically. Anon. (1960) mentioned its gregarious flowering from North Bengal probably in 1960. The seed set in this species is poor, because the flowers are attacked by the insects and therefore the inflorescence is very often found diseased. Mohan Ram and Gopal (1981) reported its sporadic flowering in the state of Mizoram during 1978-79. They believe that non availability of insufficiency of pollen for cross pollination my result into poor seed production. Haridasan (1991) reported its flowering from Lohit district of Arunachal Pradesh and stated that no fruiting could be seen. Barooah (1999) reported its sporadic flowering in 1997 from Hukanjuri Beat, Jaipur R.F., Dibrugarh and Abhaypur R.F., Sibsagar, Assam. P.Kumari and P.Singh (2014) mentioned its flowering in 1913 from Garampani (Meghalaya). In the year 2012 author (HBN) has observed its sporadic flowering Gibbon Wildlife Sanctuary near Jorhat, Assam.

Uses: Valuable bamboo and considered best for making the basket and mats, especially those used in tea factories. Also used for tying house walls.

TEINOSTACHYUM Munro

(Greek word *schistos*, cleft, divided; *stachys*, ear or corn; referring to the spaced grouping of the spikelets).

Teinostachyum dullooa Gamble

Teinostachyum dullooa Gamble in Ann. Roy. Bot. Gard. Cal. 7:101. Pl. 89. 1896. *Neohouzaeua dullooa* (Gamble) Camus in Bull. Mus. Paris, 100.1922. *Schizostachyum dullooa* (Gamble) Majumdar in Karthikeyan *et al*., Fl. Ind. Enum. Monocot. 281. 1989.

Local Name : *Siejla* (Khasi); *Tarang* (Jaintia); *Wadrow* (Garo)

Where to see it in Meghalaya: West Khasi Hills: Markasa, Nongshiliang, Sohtyngia. **East Jaintia Hills:** Umkiang. **South Garo Hills:** Balpakram National Park, Siju **Ri-Bhoi:** Nongkhyllem Reserve




A medium sized bamboo, tufted, sometimes more or less scandent. *Young shoots* sheaths purple towards the margin, black or blackish-green, long-ciliate at the top; *blades* reflexed at least at right angles, silky pubescent on the adaxial surface towards the base. *Culms* 4.9 m tall, whitish below; *nodes* hardly prominent; *internodes* 0.4-1 m long, 2.5-8 cm broad; *wall* thin. *Culm sheaths* varying in size according to internodes, from 15-30 cm long, 10-25 cm broad, striate, with scattered white hairs prominent above, rounded at the top, concavely truncate and loose-fringed with stiff bristles; *imperfect blades* 7.5-15 cm long, 8-17 mm broad, narrow, subulate, recurved, hairy within; *ligule* prominent, long fimbriate. *Leaves* variable, oblong-lanceolate, acuminate, rounded, often unequally at the base into a short petiole, terminating in a twisted, subulate point, rough on the upper surface, minutely soft pubescent beneath or glabrescent, margins rough; main vein pale, not very prominent, secondary veins 6-10 pairs, intermediate about 7, transverse veinlets absent, but a few pellucid dots which have the appearance of transverse veinlets on the under surface; *sheath* striate, ciliate on the margins, callus ciliate or glabrous; *ligule* long, hairy. There are two type of forms which are found in this bamboo i.e. that very big and small. Big size clumps are found only at Nongkhyllem Reserve Forest, Ri Bhoi. Small form are found in many places in Jaintia Hills, it is found along the stream of Umkiang. From Nongkhyllem Reserve, Ri Bhoi District, the bamboo is exported to Gujarat and Rampur and Barielly, Uttar Pradesh by District Council Forest.




Inflorescence panicle of spaciform branches, furnished with long, truncate bracts, with softly hairy, imperfect, caducuous limbs. *Spikelets* usually 2-together, slender, bracteate at the base, 1.25-2.5 cm long, slender, cylindrical-fusiform, acute, softly hairy with one fertile floret; *glumes* 2-4, ovate-acute, long mucronate, sub-aristate, the upper resembling an empty lemma; fertile floret *lemma* 12-14 mm long, convolute, lanceolate, without keels or very obscurely keeled at the apex, many nerved, hairy at the apex, terminating in two awns, which are scabrid and 1-1.5 mm long. *Stamens* 6; filaments connate; *anthers* 9-10 mm long, obtuse. *Ovary* glabrous; *style* forming a 12-14 mm long beak; *stigmas* 3, shirt, red.

Phenology: According to Gamble (1896) and Blatter (1929) this species flowered in Bhutan during 1880 and 1889 and in Myanmar during 1892, 1892-1893 and 1894. Anon. (1927) mentioned its flowering from Chittagong hills tract in 1927. Anon. (1946) stated that it flowered in Sitapur Reserve, Bangladesh during January-February, 1946 and produced fruits in May-June, 1946. Nath (1962 and 1971) mentioned its flowering during 1961 and 1971 in Assam. Gupta (1972) and Rao and Ramakrishnan (1988) have mentioned its gregarious flowering in Assam and Meghalaya respectively during 1967-1968. Hasan (1973) from Bangladesh. Banik (1999) reported gregarious flowering at Hazarikhil (Rangapani Tea garden), Chittagong in Bangladesh in 1999. Naithani and Garbyal (2010) reported gregarious flowering at Buangpui near Thenzol, Mizoram in March 2010, having no seed. Nath and Das (2010) hae reported its gregarious flowering in 2009-2010 from Cachar district of Assam. The seed of this species is very thin about 16,000 seeds weight is one pound and can not be kept for long time (Anon. 1946). Banik (2000) stated that its flowering is mostly sporadic and occasionally gregarious, he mentioned flowering cycle 45±2, 35±2 and 15±2 years, he also stated that the weight of hundred glumed seeds and deglumed seeds are 3.03 gm and 2.51 gm respectively and its germination takes place within 3-7 days of sowing with 60-75%.

Uses: This is a very important bamboo and is used to make quivers, mats, baskets, umbrellas, small boxes, kite frames. Young shoots are edible. And, they are also food item of Phayris leaf monkey during the rainy season.

Distribution: Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, North Bengal. Bhutan, Bangladesh, Myanmar and Vietnam.

Teinostachyum helferi (Munro) Gamble

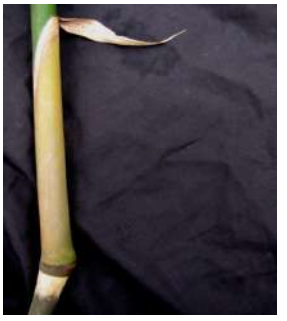
Teinostachyum helferi (Munro) Gamble in Ann. Roy. Bot. Gard. Cal. 7:102. Pl. 90. 1896. *Bambusa helferi* Munro in Trans. Linn. Soc. Lond. 26:114. 1868. *Pseudostachyum helferi* (Munro) Kurz in J. As. Soc. Beng. 42:252. 1872. *Neohouzeaua helferi* (Munro) Gamble in Kew Bull. 1922: 91.1923. *Schizostachyum helferi* (Munro) Majumdar in Karthikeyan *et al.,* Fl. Ind. Enum. Monocot. 281. 1989.



Local Name : *Tumar, Tuma* (Khasi & Jaintia); *Wali* (Garo).

Where to see it in Meghalaya: This bamboo forms thickets in the forest. **East Khasi Hills:** Sohra, Shella, Thangkharang, Laitkynsew and between Wahlang and Mawsynram. **West Khasi Hills:** Domiasiat, Mawshun. **East Jaintia Hills:** Umkiang. **West Jaintia Hills:** Syndai, Muktapur, Badarpur, Dawki, Pasadwar. **East Garo Hills:** Rongrenggiri. **South Garo Hills:** Balpakram National Park, Gokka, Siju.

An evergreen, tufted, bushy or climbing bamboo. *Culms* 6-12 m tall, spreading in all directions, grayish-green when young, sprinkled with appressed whitish bristles; *nodes* some what thickened; *internodes* with whitish band near the nodes, 50 cm –1.25 m long, 3.75 cm in diameter; *wall* thin. *Culm sheaths* 20-25 cm long, persistent, brittle, bearing few appressed white bristles which leave a scar when they fall, rough towards the base, truncate at the top; *imperfect blade* nearly as long as the sheaths, recurved; *ligule* narrow, fringed with white hairs. *Leaves* variable, 15-45 cm long, 2.5-7.5 cm broad, oblong-lanceolate, unequal at the base, shortly petioled, cuspidate-acuminate, ending in a long, scabrous, twisted point, glabrous and glaucescent beneath, margins rough; main vein thick, prominent, secondary veins 7-15, intermediate 5-7, transverse veinlets absent, pellucid glands appearing on dry specimens as transverse veinlets; *sheath* glabrous, smooth, striate, ending in a smooth callus and a short long-fringed auricle; *ligule* narrow, fringed.





Head of spikelets often large, upto 5 cm in diameter. *Spikelets* 2.5-4 cm long, usually two together, slender, prominently bracteates at the base; iglumes slender, prominently bracteates at the base, *glumes* usually two, 5-8 mm ong, mucronate, margins slightly strigosely hirsute; *lemmas* 12-25 mm long,

ovate-lanceolate, long-mucronate, strigosely hirsute, many-nerved; *paleas* 37 mm long, convolute, glabrous except at the tip, bi-aristate, the base sometimes with a free terminal rhachilla. *Stamens* 6, monadelphous; *anthers* 12-18 mm long, obtuse at apex, at length exserted. *Ovary* oblong, elongate, glabrous; *style* long; *stigmas* 3, red, short. *Caryopsis* 5 cm long, beaked, oblong, pericarp leathery.



Distribution: Uptill 1984 this species was known only from Meghalaya. The author (HBN) has reported it from East Siang district, Arunanchal Pradesh.

Phenology: According to Blatter (1929) this species flowered in Garo hills, Meghalaya in 1889 and in Toungoo district, Myanmar in 1922. De (1940) reported its flowering in 1940 from Garo hills, Meghalaya. According to information available on herbarium specimen, Panigrahi 22504, it flowered in December, 1960 in Garo hills. On the basis its flowers/ seeds deposited in the Carpological Museum, Foresr Research Institute, Dehra Dun its flowered in March 1922 in West Salween Division of Mynamar.

YUSHANIA Keng f.

Etymology: Yushanzhu Shu (Chinese), *meaning* Yushan bamboo genus.

Yushania hirsuta (Munro) Campbell



Yushania hirsuta (Munro) Campbell, Note. Sino Himal. Bamboo Spect. 46. 1988; Pushpakumari & P.J.Singh in NELUMBO 52:122.2010. *Arundinaria hirsuta* Munro in Trans. Linn. Soc. Lond. 26:30. 1868. *Sinarundinaria hirsuta* (Munro) Chao & Renvoize in Kew Bull. 44:355. 1989.

Local Name : *U-stoh, Kdait, Stew Dait-si-sai, U-stewiong* (Khasi)

Where to see it in Meghalaya: East Khasi Hills: Mawphlang, Mawsynram, Nongkrem, Sohiong, Upper Shillong. Elephant Falls, Nongkrem. **West Khasi Hills:** Mairang



A shrubby bamboo with single stem from the rhizomes. *culms* 1-2.5 m tall, 5-7.5 mm in diameter, grayish-green; *nodes* glabrous, raised; *internodes* upto 32 cm long, often strigosely hirsute above;*wall* rather thin. *Culm sheath* papery, 15 cm long, 2.5 cm broad at the base, striate, covered with long brown hairs, rounded at the apex and ending in large, recurved, long-ciliate, *auricles*; *imperfect blade* subulate, acuminate, recurved; *ligule* narrow, pubescent. *Leaves* oblong-lanceolate, 7-12.5 cm long, 12-17.5 mm broad, rounded at the base into a short petiole, terminating above in a subulate, twisted, scabrous point, smooth above, pale and strigosely white hairy beneath, margins cartilaginous and scabrous-serrate; main vein narrow, shining, secondary vein 4-6 pairs, intermediate 7, transverse veinlets very numerous,straight, regular and strong; *sheath* striate, covered with long stiff bristles, ending in a hairy callus, and rounded reflexed auricles, bearing long, stiff almost spinescent hairy bristles; *ligule* elongate, hairy, often dark coloured.



Inflorescence a terminal panicle on leafy branches; rachis angular (triangular type), striate smooth, glabrous on most of the part, often fine white hairy below. Spikelets distant, purplish, on 0.6-2 cm long pedicles, 3-spikelets originating at the first node of rachis, then 2 and finally single spikelets towards apex, lower spikelets 1-1.2 cm long, reaching up to 2.2 cm at apex, 4-7 flowered with terminal imperfect flower; rachilla 4-5 mm, towards

terminal floret shorter, c.2 mm, flattened, white hairy at apex, glabrous below; empty glumes 2, lower c.4 and upper c.5 mm long, ovate-acute, upper keeled, scabrously ciliate at keel above, fine ciliate at apical margins, faintly 5-7 nerved; lemma 8-9 mm long, 3-4 mm broad, ovate-acuminate, keeled, mucronate, minute hairy above on outer surface, sparsely minute hairy near apex on inner surface, short ciliate at apical margins, faintly 9-nerved; palea 6-7 mm long, oblong-lanceolate, shorter than lemma, 2-keeled, ciliate at keels, bifid and bimucronate at apex, faintly 2-nerved, minutely hairy above between keels and on either side; lodicules 3,c. 1.5 mm, ovate-acute, long fimbriate along margin, hyaline; stamens 3, c.2 mm long, saggitate, blunt at apex; ovary c.5 mm, ovate glabrous, with two soon dividing, short, hairy, c.1.5 mm long stigmas.

Distribution: Sikkim and Meghalaya in India.

Phenology: It has only flowering record from Shillong in 2004 (P.Kumari and P.Singh, 2014).

Uses: It is used for walling of huts which are plater with mud.

SPECIES EXCLUDED

Following species have been excluded from the present work

Bambusa khasiana Munro

This species is far known only by its type collection from Cherrapunjee (Sohra) made by Hooker & Thomson. Also recorded by them flowering in 1850 from Jaspar hills, Mahadeb (Meghalaya). After that there is no record on its occurrence. During present survey no population could be located.

Dendrocalamus calostachys (Kurz) Kurz

Naithani (1985) erroneously reported the occurrence of *Dendrocalamus calostachys* from Nagaland and Meghalaya. From Meghalaya it was mentioned on the basis of a collection made by N.L.Bor in 1944 from Shillong acc. No. 18385 deposited in the herbarium of Forest Research Institute, Dehra Dun. From the publication of P.Kumari and P.Singh (2014) it indicates that have not collected any specimen from Meghalaya. Thus probably the presence of *D.calostachys* in their book is based only on the publication (Naithani, 1985). While bamboo survey in Nagaland author has critically checked the live material from Kohima Nagaland an it was found both specimens from Nagaland and Meghalaya deposited in the herbarium of Forest Research Institute, Dehra Dun as *D.calostachys* are different, which were later confirmed as *Dendrocalamus latiflorus* Munro (Naithani 2006b). Today *Dendrocalamus latiflorus* Munro is commonly planted at Nagaland and Manipur. However, during recent survey in Meghalaya author could not locate neither *Dendrocalamus calostachys* (Kurz) Kurz nor *Dendrocalamus latiflorus,* Munro.

Drepanostachyum hookerianum (Munro) Keng,f. **(***Himalayacalamus hookerianus*(-Munro) Stapleton, *Sinarundinaria hookeriana*)

This species generally found north of Bhramputra river i.e. Sikkim, North Bengal, Arunachal Pradesh, Bhutan and Nepal. P.Kumari and P.Singh (2014) have mentioned its occurrence on the basis of a publication (Tewari, 1992) they themselves could not located from Meghalaya. During present study neither any herbarium specimen from Meghalaya is deposited in any of the herbaria, nor it was found in the field from Meghalaya.

Drepanostachyum kurzii *(*Gamble) Pandey (syn. *Arundinaria kurzii* Gamble)

It is a native of Myanmar and has not been recorded from India. Even no specimen of it is deposited from Meghalaya in any herbarium. However, Tiwari (1992) have mentioned its occurrence from Meghalaya. During present survey no population of its could be located. P.Kumari and P. Singh (2014) also failed to locate this species from Meghalaya. In their publication under general distribution they have mentioned Meghalaya, Manipur, Nagaland, West Bengal. Its occurrence mentioned by P.Kumari and P.Singh (2014) desire confirmation.

Drepanostachyum polystachyum (Kurz ex Gamble) Majumdar (*Arundinaria polystachya* Kurz ex Gamble)

Only record of its occurrence from Meghalaya is based on a collection made by G.Mann in 1876 from Khasi hills, which was quoted by P.Kumari and P.Singh (2014), this indicate they have not collected this species in the field. During present survey it could not be located from Meghalaya.

Gigantochloa macrostachya Kurz and **G.rostrata** Wong

P.Kumari and P.Singh (2014) mentioned *G.macrostachya* and *G.rostrata* from Meghalaya and stated that in the present work it is reported on the basis of unconfirmed specimens and described as per literature only. While Naithani (1999) stated that *Gigantochloa macrostachya* Kurz (syn. *G.rostrata* Wong) has no distribution in India. It is so far known only from Myanmar and Malaya.

Teinostachyum griffithii Munro (syn. *Schizostachyum griffithii* (Munro) Majumdar).

P.Kumari and P.Singh (2014) quoted only specimen i.e. collected by Griffith from Khasi Hills Meghalaya. However in the field they have not collected any specimen. During present survey no population of it was located from Meghalaya.

Yushania microphylla (Griff.) Majumdar (syn. *Arundinaria microphylla* (Griff.) Munro)

From Meghalaya this species is known by a single collection made by H.G.Carter from Elephant falls in June 1920 which was quoted by P.Kumari and P.Singh (2014). After H.G.Carter 1920, there is no record of its occurrence from Meghalaya. During present survey no population of it was located.

P.Kumari and P. Singh (2014) has erected a species *Bambusa nairiana* which has been now merged under *Bambusa nutans.* Another species viz *Bambusa pallida* Munro reported by them from Barapani is erroneously identified and has now been kept under *Bambusa pseudopallida* Majumdar. *Bambusa teres* Buch.-Ham. ex Munro and *Bambusa tulda* var. *gamblei* P.Kumari and P.Singh now been merged under *Bambusa tulda.* And *Gigantochloa apus* sensu Majumdar non (Bl. ex Schult.f.) Kurz has been kept under *Gigantochloa andamanica.*

Yushania niitakyamensis (Hayata) Keng f.

A bamboo native of Taiwan. P.Kumari and P.Singh (2014) mentioned its occurrence from Ward lake, Shillong by quoting the reference of a herbarium specimen collected by R.B.Majumdar in the year 1979. This indicate that P.Kumari and P.Singh themselves could not locate it in Ward lake. Present authors also failed to locate it.

Regarding the distribution of above mentioned species in Meghalaya Kharlyngdoh and Barik (2008) have stated that in their field visit E.Khasi hills, W.Khasi Hills, Jaintia Hills, Ri.-Bhoi, E.Garo Hills, West Garo Hills districts during 2005-2007, species viz. *Arundinaria kurzii, Bambusa khasiana, Bambusa teres, Dendrocalamus calostachys, Gigantochloa kurzii, Schizostachyum griffithii, Schizostachyum pallidum, Sinarundinaria hookerianum, Sinarundinaria intermedia, Sinarundinaria macrophylla* and *Sinarundinaria polystachya* reported by earlier workers from Meghalaya were not located.

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GLOSSARY

A

abaxial : the side facing away from the axis of the plant syn. dorsal, opp. ventral

abjoint : to separate at a joint

abrupt : terminating suddenly as though cut off

acantha : a spine, prickle, or thorn

acanthocephalous: having a hooked beak

accrescent: increase in size with age

accumbent: lying against and face to face; lying in contact; reclining

acerate, acerose: having the shape of a needle; needle-like

acicular: needle-shaped, having needle like projections

aculeate: prickly, thorny, armed with spines

acuminate: having a long, slender, sharp point with concave sides, margins straight convex

acute: sharp-pointed

adaxial, adaxial surface : the sides towards the axis; the surface of a leaf that faces the stem during development, eg. the upper side of the leaf. syn. ventral

delphous: stamens united by their filaments

adherent: a condition where two dissimilar organs touch each other but are not fused together

adnate, adnation: origanically united or fused with another dissimilar part

adpressed (appressed) : lying flat for the whole length of the organ

adventitious : plant organs produced in an unusual or irregular position as in adventitious buds, roots or shoots

adventitious embryo, : an embryo found without fertilization, which develops directly from the outer the embryony tissue of parental sporophyte, usually from the integument of the nucellus

affinis : closely related to another

affinity : similarity between entities in regard to morphological traits

aggregate : clustered together to form a dense mass or head, usually applied to an inflorescence

albino : a plant having colourless chromatophores due to lack of chlorophyll

alluvial soil : a type of azonal soil which is highly variable and is classified by texture from fine clay/silt soils through gravel and boulder deposits

alluvium : soil, usually rich in minerals, deposited by water, as in a flood plain

alternate : arrangement of leaves or plant part which are not opposite or whorled out are placed singly on the axis or stem at different heights

amplexicaul : clasping the stem, as the base of certain leaves

ancipital : two-edged; flowered or compressed axis stems of certain grasses

anemophilous, : referring to flowers which are wind-pollinated

anemophily aneuploid, aneuploidy: an organism whose somatic chromosome number is not an exact or even multiple of the basic haploid number

aniso : a prefix meaning unequal

anisolateral : with unequal sides

anisomerous : with unequal number

antrorse: bent or directed upwards or forward. opp. retrorse

aperturate : with aperture, an opening

apex, apices : the tip, the terminal end

apical : at, near, or belonging to the apex or point of the tip

apiculate: a short, abrupt or acute point

apomixis: reproduction, including vegetative propagation, which does not involve sexual processes; the ability of plants to produce seeds without fertilization

appendage : an attached subsidiary or secondary part, as a projecting or hanging organ

applanate : flattened horizontally; without vertical curves or buds

appressed : closely and flatly pressed against the entire length of an organ or part

approximate : close to each other but not united

arborescent : of tree like habit; resembling a tree in growth or appearance

arboretum : a place where trees, shrubs, and other plants are grown for scientific and / or educational purposes

arcuate: moderately curved or arched, like a bow

arista : a bristle-like appendage as on the glumes of many grasses; a bristly awn

aristate : bearing a stiff bristle-like awn or seta; tapering to a narrow elongated apex

aristulate : bearing a small awn

articulate : jointed

asymmetrical : lacking symmetry; irregular in shape or outline

attenuate : with a long, slender taper, more gradual than acuminate; applied to base or apices of parts; gradually tapering

atypical : not typical, departing from the type form

auricle : an ear-like lobe

auriculate : bearing auricles

auriculiform : usually obovate in outline with two small rounded basal lobe

awl -shaped : narrow and gradually tapering to a sharp point; sharp- pointed from a broader base

awn : a bristle like appendage or part of, as in the back or at the tip of glumes and lemmas of many grasses

axial : of or pertaining to an axis, especially main axis

axil : the angle between the stem axis and a leaf petiole, branch or other appendage attached to it

axile : of, belonging to, or located in the axis; central in position

axillary : in an axil

axis, pl. axes : the main stem of a plant ; the main or central line of development of any plant or organ

B

bacca : fruit with thick fleshy pericarp separated from seed coat

baccate : like a berry, pulpy or fleshy

bacciferous : producing berries

bacciform : shaped like a berry

BAP : benzyl amino purine

barbate : bearded with long stiff hairs (trichomes), usually in a tuft, line or zone

barbed : bristles or awn that have short-terminal or lateral spine like hooks that are bent sharply backward

barbellate : with short, usually stiff hairs

barbellulate : finely barbed

basicaulous : near the base of the stem

basifixed : a structure attached or fixed by its base to a support

beak : a firm, slender projection on certain fruits seeds and carpels

beaked : ending in a beak

beard : a cluster of bristle-like hairs or awns

bearded : bearing long or stiff hairs

berry : a fruit developed from an ovary containing one to several carpels in which the ovary wall and the inner structures of the ovary become enlarged and juicy, seeds within have their own hard seed coat

BHC : benzene hexachloride

bifid : forked; two-cleft; divided into two parts or lobes

bifurcate : divided into two forks or branches

bilobed : having two divisions, often rounded

bilocular : two-celled or with two locules

biotic : pertaining to life

bipartite : divided into two parts almost to the base

bisected : completely divided into two parts

biseriate : in two whorls or cycles; in two rows or series

biserrate : margin type with smaller sharply cut teeth on the margins of larger sharply cut teeth; doubly-serrate

blight : a plant disease where there is a sudden wilting or death of plant parts

bract : a modified, often much reduced leaf subtending a flower or inflorescence; morphologically a foliar organ

bracteate : possessing or bearing bracts

bracteolate, bracteole : possessing small bracts; a secondary bract, often very small

bracteose : having many bracts

bractlet : a small secondary bract-borne on a pedicel as petiole, instead of subtending it

bristle : a stiff strong trichome (hairs)

bud : an undeveloped shoot containing the embryonic meristems which develop into flowers, stem, or leaves, and are enclosed in protective specialized leaves termed bud scales

bud scales : specialised protective leaves which cover the shoot apex and embryonic leaves of a winter bud, preventing dessication and injury

bud scale scars : scars left on a twig by the abcision of bud scales from the terminal buds of the previous year

bulliform cells : large, thin- walled cells present in the leaves of most of monocots

bundle cap : sclerenchyma or thick-walled parenchyma associated with a vascular bundle and appearing like a cap on the phloem or xylem side, as seen in cross-section

bundle sheath : a special layer, or layers of cells which enclose the vascular bundles of dicot and monocot leaves. The cells are of often parenchyma or some times of sclerenchyma

butt : the base of a plant from which the root springs

C

caducous : falling or dropping off very early

caespitose : see cespitose

calcarate : with a spur; spurred

callus : a tissue composed of large thin-walled parenchyma cells which develop on or below a wounded surface often resulting in a firm thickening or protruberance

calyculus : a simulated calyx composed of bracts or bractlets

campanulate : bell-shaped

canescence, canescent : covered with dense, fine, greyish-white hairs; becoming hoary, usually with a grey pubescence

canopy : the cover or horizontal projection of the vegetation of a plant formed by its leaves, branches etc.

capillary, capillate: very slender, resembling a hair

capitate : formed like a head; aggregated into very dense clusters or heads

carnose : fleshy

cartilaginous : like cartilage in texture; firm and elastic

caryopsis : a one-seeded, dry, indehiscent fruit with the seed coat adnate to the fruit wall (pericarp), derived from a one- loculed superior ovary; the grain or fruit of grasses

caudate : bearing a tail, or tail-like appendage

caudex : a shoot thickened, often woody, vertical or branched perennial stem, usually subterranean or at ground level

cellulose : a complex carbohydrate, the chief component of the cell walls of most plants; it consists of long chain-like molecules of glucose which form microfibrils

ceraceous, ceriferous : waxy; wax-bearing

cernuous : nodding or drooping

cespitose, caespitose : matted, growing in tufts or small dense clumps; plants forming a cushion

chartaceous : papery in texture, opaque and thin

ciliate : fringed with conspicuous hairs along the margins

clasping : a leaf blade which partly or wholly surrounds the stem

clavate : club-shaped; gradually thickened towards the apex from a slender base

claw : the modified auricle of some grass leaves

closed bundle : a vascular bundle in which a cambium does not develop

closed venation : leaf characterised by anatomosing veins

comose: bearing a tuft of trichomes, usually apically

coleoptile : a protective sheath like structure enclosing the epicotyl in seeds of grasses

concrescent : growing together of parts originally separate

congeneric : belonging to the same genus

conglomerate : densely clustered

connate : union or fusion of like parts or organs to one another

connate-perfoliate : opposite, sessile leaves, instead at their bases, surrounding the stem

connective : an extension of the filament, connecting the two cells of an anther

conspecific : within or belonging to the same species

convolute : rolled up longitudinally and usually twisted apically

cordate : heart-shaped, having notched end at the base and the pointed end at the apex

coriaceous: thick, tough and leathery

corniculate : bearing or terminating in a small horn-like process

corrigate : irregularly folded or wrinkled

crassinucellate ovule : one of two general type of nucellar organization found in angiosperms in which the megasporocyte forms a sporogonous cell deeply embedded with in the nucellus

crenate : shallowly ascending round toothed or teeth obtuse

crispate, crisped: irregularly curled leaf margin or trichome

crustaceous : hard, thin and brittle

cucullate : hooded or hood-shaped

culm : the stem of a grass or sedges

culm leaf : consists of a sheath, blade, liqule and auricles

culm sheath : the sheath of the culm leaf, borne singly at each node of the culm proper, below the level at which the sheath of foliage originate

cuneate, cuneiform : wedge-shaped; triangular, with the narrow part at the point of attachment

cuspidate : with an apex somewhat abruptly and sharply constricted into an elongated, sharp-pointed tip or cusp

cuticle : a noncellular layer of waxy or fatty materials on the outer wall of epidemal cells

cutting : a vegetative portion removed (cut) from a plant for the purpose of propagation

D

damping off : a fungal disease of seedlings which causes them to rot and shrivel at soil level, or to die before they emerge rom the soil

deciduous : the falling of parts at the end of a growing period

declinate : bend or directed downwards or forward

decumbent : a growing habit in which a portion of the stems or shoots lie close to the ground, without rooting adventitously, the upper parts of the stem are erect or ascending

decurrent : an extension of tissue occurring down the stem below the point of insertion of a leaf petiole or ligule, forming a wing or ridge.

decussate : opposite leaves alternating at right angles with those above and below

deflexed : reflexed; bent or turned adruptly downward

dentate : with toothed margin

denticulate : minutely toothed, finely dentate

depressed : pressed downward close to the axis

determinate : growth of limited duration

determinate : an inflorescence in which the terminal or central flower develops first, thereby

inflorescence : asserting further elongation of the inflorescence axis

dichogamy : in a bisexual flower, maturation of stamens and stigma at different times, thus preventing self-pollination

dichotomous : branching by repeated forking in pairs

dieback : a progressive death of plant shoots beginning at the tip

diffuse : the loosely branching or spreading; widely spread

digitate : finger like

dilated : flattened and broadened

dimidiate : unequally divided in two

discrete : separate, not coalesced

dissected : deeply divided

distal : opposite from the point of origin or attachment towards the apex

diurnal : opening during the day

DMSO : dimethyl sulphoxide

dorsal : the lower or undersurface of a leaf; abaxial

E

ebracteate : without bracts

ecotone : a transition zone; a region of overlapping plant association, between two adjascent ecosystems

edaphic : pertaining to, or influenced by, soil conditions

elliptical, elliptic : oval in outline but widest about the middle

emarginate : bearing a shallow notch at the apex

endemic : native or confined naturally to a particular and usually very restricted geographical area or region

endocarp : the innermost layer of the pericarp or fruit wall

ensiform, ensate : sword-shaped

entire : without indentations or incisions on the margin; smooth

epicotyl : portion of the axis of an embryo

erect : directed towards summit, not decumbant

explorate : spread out flat

explant : an exised tissue or organ fragment which is used to initiate an in vitro culture

exserted : projecting beyond, sticking out or protruding

extrorse : opening or facing outwards

F

falcate : sickle-shaped

fallow : agricultural land left uncultivated for one or more seasons to allow for the accumulation of moisture, destruction of weeds, and the decomposition of organic matter

fariaceous, farinose : covered with a mealy powder

fascicle, fascicled : a close cluster of flowers, leaves etc. in groups (bundles)

filiform: thread like, flexuous

fimbriate : margins fringed, with long and coarse hairs

fistular, fistulose : hollow and cylindrical

fibre : long, narrow cell of wood or bark other than vessel or parenchyma elements

fibre saturation point : the point at which there is no more free water in the culm, but the cell walls are still saturated with water

flagelliform : whip-shaped

flexibility ratio : parameter used by the pulps and paper industry, desired from the fibre

dimensions of the culm, fibre lumen diameter divided by fibre diameter, multiplied by 100

flexuous : coarsely sinuous or wavy; curved alternately in opposite directions

FRI : forest research institute

FTIR : fourier transform infra-red

furcate : forked

fusiform : spindle-shaped

G

gemmiparous : producing a bud or reproducing by a bud

germplasm : collection of genotypes of an organism

geniculate : abruptly bent at a joint, like a bent on knee

genus : the smallest natural group containing distinct species

gibbous : swollen on one side near the base

girdle : a conspicuous horizontal band of tissue inserted circumaxially at the node of some bamboos

glabrous : without pubescence; not hairy

glans : a fruit with hard, smooth crustaceous pericarp separated from seed coat

glaucous : covered with a removable waxy coating which gives the surface a whitish or bluishs green cast

globose, globular : spherical or rounded

glomerate : in dense or compact clusters or head

glumes : a pair of small scale like bracts subtending a grass spikelet

glutinous : with stickly exudate

gregarious : growing in groups or colonies; in bamboos, gregarious flowering is used to indicate that a whole population over a period of time

H

habit : the general appearance or characteristic from of a plant, or other organisational erect, prostrate, climbing etc.

habitat : the natural environment of an organism; the place where it is usually found

hemi : a prefix meaning half

hemicellulose : a polysaccharide resembling cellulose but more soluble and less complex; a common component of the cell wall matrix

herbarium : a collection of dried and pressed plant specimens, ystematically arranged

and labelled; used for taxonomic studies

heterogeneous : not uniform

hexaploid : having six haploid chromosome sets (6n)

hilum : a scar on a seed marking the point of attachment to the funiculus

hirsute : covered with rather rough and stiff hairs

hispid : covered with long, stiff trichome; usually stiff enough to penetrate the stem

hoary : covered with a white or greyish-white pubescence: syn. canescent

holosericeous : covered with fine and silky pubescence

holotype : the single specimen, the type specimen designated to carry the name of a new species

homogenous : uniform, alike; having the same nature or consistancy

homonym : in nomenclature, a name rejected because it duplicates a name previously and validly published for a group of the same taxonomic rank and based on a different type

humus : decomposing organic matter in the soil

hypogeal, hypogean : describing seed germination in which the cotyledons remain beneath the surface of the soil

I

IAA : indole acetic acid

IBA : indole butyric acid

imbricate : with margins of structures overlapping

incanescent : becoming grey

incised : leaf margins cut sharply, irregularly and deeply

incrassate : thickened

increment : addition, increase

incumbent : lying or leaving upon; anthers turned inward

incurved : curved inward or upward

indefinite : indeterminate

indehiscent : not dehiscent, remaining closed at maturity

indeterminate growth : unrestricted growth, as with a vegetative apical meristem, capable of producing an unlimited number of lateral organs

indigenous : native to a region or country

inflexed : bent abruptly inward

innate : borne at the tip of a supporting structure

imperfect stage : the part of life cycle which reproduces only by asexual means

inserted : growing upon or attached to

integument : the outer cell layer which surrounds the nucellus of the angiosperms ovule and develops into the seed coat

intercoastal : space between ribs

internode : the portion of the stem between two successive nodes

introduced : brought into one area or region from another

introrse : turned inward towards the axis; as the opening of an anther towards the inside of a flower

invaginated : enclosed within a sheath

inverted : upside down; turned over

involute : margins rolled or turned in over the upper or ventral surface

isotype : a specimen of the type collection other than the holotype; a duplicate of the holotype

isozymes : different forms of the same enzyme

K

keel : a sharp crease or ridge; the two united petals of a paplionaceous flower

keeled : having a keel, sharply creased

KFRI : kerala forest research institute

kiln dried : being seasoned in a kiln

KN/mm^2: kilo newton per millimetre square

kraft pulp : sulphate pulp

L

Labiate : lipped; having a lipped structure

lacerate: cut irregularly, appearing torn, as in certain leaves and liqules

laciate : cut deeply into closely parallel, narrow divisions

lamella : a thin plate or layer of photosynthetic membranes

lamina : thin and flattened, a leaf blade

lanate, lanose : woolly, cottony, covered with long, fine, intertwined trichomes (hairs)

lanceolate : much longer than broad; widened above the base and tapering towards the apex

lateritic soil : a relatively infertile soil characteristics of tropical and subtropical areas, usually red in colour due to the presence of iron oxides, they are highly acidic and have little organic matter

lax : loose, not densely packed

leach : downward movement of minerals through the soil by percolating water

leaf scar : a scar or mark left on a stem when a leaf falls, indicating the former place of attachment of the petiole or leaf base

leaf sheath : the basal portion of a leaf blade or petiole that more or less completely surrounds the stem

lectotype : a specimen selected from the original collection of plant material, to serve as the nomenclatural type when the holotype is missing, or if it was not designated when the taxon was first published

lemma : one of the pairs of bracts (lemma and palea) that subtends the floret. The lemma is lower, usually larger, and frequently bears an awn, which is the extension of its midrib

lenticular : lens-shaped; double convex with two edges

leptomorph : one of two general type of rhizomes, characterised by a slender stem, long internode and indeterminate growth

libriform fibre : a xylem fibre commonly with thick walls and simple slit-like pits

lignin : a complex organic substance derived from phenypropane and distinct from carbohydrates

liqule : a membranous out growth on the upper surface of a grass leaf at the junction of the sheath and the blade. It may be presented by a ridge or by a line of hairs; an elongated flattened strap shaped structure

linear : long and narrow with sides parallel

lobate : divided into lobes

lodicule : one of two or three minute hyaline scales of the base of the stamens of most grasses (poaceae)

longitudinal : lengthwise

lumen : the space enclosed by the walls of an organ, such as the central cavity of a cell the central cavity of a hollow internode of a bamboo plant

M

maculate : spotted or blotched

marginate : having a distinct margin

membranaceous, : thin, soft, flexible, and more or less translucent membranous

meristem : undifferentiated tissue of the growing points whose cells are capable of di-

viding and developing into various organs and tissues

mesophyll : the photosynthetic tissue between the upper and lower epidermis of a leaf

microclimate : the climate in the immediate vicinity of an organism

microfibril : the primary structural components of a plant cell wall, composed of chain-like cellulose molecules

micropyle: a small opening with integuments of an ovule through which the pollen tube usually enters to reach the nucellus

midrib : the main vein of a leaf which is a continuation of the petiole

middle lamella: an inter cellular substance, composed mostly of pectic compounds, that counts the primary walls of contiguous cells

modulus of elasticity : modulus of elasticity (in N/mm^2) indicates the ratio (MOE) between the bending stress in the material and relativedeformation caused by this bending stress; it is a measure of rigidity

modulus of rupture: fibre stress at maximum load , maximum fibre stress, (MOR) ultimate bending stress necessary to bring about future of the tested material when bent (in N/mm^2)

moisture content (MC) : the weight of water in the culm expressed as a percentage of the dry weight of the culm

monadelphous: stamens united by connation of their filaments into a single group forming a tube or column

monopodial : a form of branching in which lateral branches usually originate at some distance from the apex of the main axis. In bamboos, a primary axis continues its original line of growth from the same apical meristem to produce successive lateral branches

mosaic : with a variegated or mottled appearance

mother cell : precursory cell

mottled : with blotched or spotted appearance

MS medium : murashige and skoog's medium

mucronate : terminated adruptly in a short stiff point

multicoastal : many-ribbed

muricate: rough, as a surface covered with many minute, sharp protruberances

muticous : pointless, blunt, awnless

N, O

NNA : naphthalene acetic acid

naturalized : an organism which is well-established and reproducing in one area but

originally came from another area, introduced to a new area

neck : the constricted basal part

necrosis : the death of cells

N/ mm^2 : newton per millimetre square

node : a region on this stem where leaves are attached; or the point of branching of the stem

nomenclature : naming of things, particularly organisms; correct usage of scientific name used in taxonomy

nucellus : the tissue of an ovule, from which the embryo sac develops

obcordate : inversely cordate with the notch at the apex

oblanceolate : inversely lanceolate; with the broadest portion nearest the apex and tapering toward the base

oblique : slanted; with unequal sides

oblong : much longer than broad with nearly parallel sides

obovate : inversely ovate, with the terminal half broader than the basal

obtuse : blunt or rounded at the apex

offset : a short, lateral shoot or branch which develops from the main stem producing a means of vegetative propagation

orbicular, orbiculate : more or less circular in outline or shape

oval : broadly elliptical, the width more than half the length

ovate : egg-shaped in outline, with the axis widest below the middle

ovoid : an object that is oval in outline

ovulate : bearing ovules

P

pachymorph : one of two general types of rhizome, characterised by a shortened thick and fleshy stem end determinate growth; its growth produces many-branched clumps which terminate in flowering stalks

palea : the upper or inner of a pair of bracts that subtends the floret

paleaceous : having small membranous scales

panicle : an indeterminate inflorescence, the main axis of which is branched, with pedicellate flowers borne upon the secondary branches

paniculate : having a panicle type of inflorescence

pantropical : distributed throughout the tropics

papillae : a soft, nipple-shaped protuberance

parenchyma : tissue composed of more or less isodiametric cells, as in pith and mesophyll

parthenocarpy : the natural or artificially induced development of fruit without sexual fertilization

pedicel : the stalk of an individual flower in an inflorescence or the stalk of a grass spikelet

PEG : poly ethylene glycol

pendent, pendulous : suspended, drooping, hanging down from a support

penicillate : ending in a tuft of fine hairs or branches

percolation : the downward movement of water through the soil

perennial: a plant which lives for more than two years and usually flowers every year

perfect flower : a flower having both stamens and carpels

pericarp : the mature fruit wall which develops from the ovary wall, frequently differentiated into distinct layers; exocarp, mesocarp and endocarp (outer, middle, and inner layers)

periclinal : parallel to the surface

perigynium : a sac like bract which surrounds the pistillate flower or achene

persistent : remaining attached, not falling off

petiolate : having a petiole

petiole : the stock of a leaf

phloem : the principal food-conducting tissue of a vascular plant which is usually composed of sieve elements, parenchyma cells, fibres and sclereids

pileate : having a cap or cap-like structure

piliferous : hair-like, flexuous

pilose : having soft, long, shaggy trichomes

plicate : plaited, fan-like

plumose : covered with a fine, feather like pubescence

plumule : the first bud of an embryo, the part of the embryonic axis above the cotyledonary node

prickle : a sharp-pointed epidermal or cortical outgrowth

proembryo : an embryo in the early stages of development

proproots : aerial roots

propagule : a part of a plant that becomes detached and grows into a new plant

prophyll : one of the first leaves of a lateral branch; a bracteole or small scale like appendage

protogyny : flowers in which the stigma becomes receptive prior to maturation of anthers and dehiscence of pollen in the same flower

proximal : the part nearest the axis

pruinose : having a heavy waxy bloom on the surface

pruning : cutting off the superfluous branches or shoots of a plant for better shape or more fruitful growth

pseudospikelet : a spikelet-like branch of an indeterminate inflorescence

pubescence, pubescent : covered with short, soft trichomes

punctate : dotted with minute depressions

pulp : the soft fleshy part of the fruit; mechanically ground or chemically digested wood used in manufacturing paper and allied products

Q , R

quadr, quandra, quadric : a prefix meaning four

raceme : an unbranched, indeterminate inflorescence, in which the individual flowers are borne on pedicles along the main axis

racemose : like a raceme; having flowers in raceme like inflorescence that may or may not be true racemes

rachilla : a diminutive or secondary axis, as the stalk of the spikelets of grasses

rachis : the axis of a compound leaf upon which the leaflets are attached; the major axis of an inflorescence

radial : lengthwise, in a plane that passes through the pit; radiating, as from a centre

ramified, ramiform : branched; branching

radical : arising from the root, or its crown

radicle : the first root of an embryo or germinating seed

rhomboidal : diamond-shaped

recurved : bent or curved downward or backward

reflexed : abruptly bent or turned downward or backward

reniform : kidney-shaped

reticulate : forming a network

rhizome : an underground stem which is distinguished from a root by the presence of

nodes, buds and leaves or scales

rostrate, rostrum : having a beak

ruffled : having a very strong wavy margin

rugose : wrinkled, covered with coarse reticulate lines

Runkel ratio : parameter used by the pulp and paper industry, derived from the fibre dimensions of the culm; twice the fibrewall thickness divided by the fibre lumen diameter

runner : a specialized stem that develops from a leaf axil at the crown of a plant, grows horizontally along the ground and forms a new plant at one of the nodes, usually at or near the tip

S

sagittate: shaped like an arrow head; triangular-ovate with two straight or slightly concave basal lobes

scabrid: roughened

scabrous : having a surface that is rough to touch, because of the presence of short stiff hairs

scale : any thin, usually small and dry, scarious to coriaceous bract

scandent : climbing

scarious : a thin, nongreen, dry, membranous structure

sclerenchyma cell : a supporting cell, variable in form and size, having a more or less thick, often lignified secondary cell walls. Includes fibres, fibre-tracheids and sclerieds

scurfy : covered with minute, branch like scales; with scaly incrustation

scutellum : single cotyledon of a grass embryo

seepage : percolation of water through the soil

senescence : the aging process

septate : being divided or partitioned by cross walls into locules or cells

sericeous : having a saw-toothed margin with sharp teeth pointing forward or toward the apex

serrate : toothed like a saw

sessile : without a stalk

setaceous : having bristle like hairs; bristly

sheathing base : a leaf base that surrounds a stem

sieve element : a cell of the phloem concerned mainly with the longitudinal transport of food materials

siliceous, silicious : composed of or impregnated with silica (silicon dioxide)

sinuous : having a strongly wavy margin

slenderness ratio : parameter used by the pulp and paper industry, derived from the fibre dimensions in the culm; fibre length divided by the fibre diameter

sparsely : scattered

spatulate : spoon or spatula-shaped

spicate : having the form of or produced in a spike

spike : a simple indeterminate inflorescence with sessile flowers along a single axis

spikelet : a secondary spike, one of the units of which the inflorescence consisting of one or more florets on a thin axis, subtended by a common pair of glumes as ingrasses

spinose, spinous : spine-like, or having spines

sporadic : widely dispersed or scattered; irregular in time, flowering at irregular intervals

stipitate : borne on a stipe or stalk

straggling : extremely divergent, spreading very far apart

striate : marked with fine longitudinal parallel lines, as grooves or ridges

subspecies : a subdivision of a species, in rank between a variety and a species

subulate : awl-shaped, tapering from base to apex

sulcate : having longitudinal grooves, furrows or channels

strigose : having straight, sharp, stiff, appressed hairs frequently with a bulbous base

sympodial : of a stem in which the growing point either terminates in an inflorescence or dies, growth being continued by a new lateral growing point

T

tangential: lengthwise, in a plane at right angles to the radius but not passing through the pith

tawny : dull yellowish-brown; fulvous

terete : more or less circular in cross section; cylindrical and elongated

terminal : found at the tip, apex or distal end

tesselate : having a checkered pattern

tomentose : covered with dense, matted, woolly hairs

tortuous : cut off more or less squarely at the end; a base or apex which ends abruptly

trigonal : three-angled

truncate : a base or apex which ends abruptly almost right angles to the main axis

tufted : in clumps; clustered, cespitose

turbinate : shaped like a top; inversely conical

unarmed : devoid of thorns, spines or prickles

undulate : a margin wavy (up and down) in the vertical plane

uni: a prefix meaning one or single

unitegmic ovule : an ovule with a single integument

V

vaginate: sheathed

varicose : abnormally and irregularly enlarged or swollen

vein : a strand of vascular tissue in the organs like leaf or petals

ventricose : enlarged or swollen unequally; inflated on one side near the middle. syn. gibbose;

velvety : with a matting of the soft hairs; the same as tomentosebut dense so that the surface feels very smooth

ventral : facing central axis

verticillate : arrangement in whorls, arising at same node

villose : with long weak hairs

viviparous, vivipary : germinating or sprouting of bud or seed still attached to the parent plant