Grasses of North-Eastern India

U. Shukla

Scientific Publishers, Jodhpur/India

THE GRASSES OF NORTH–EASTERN INDIA

THE GRASSES OF NORTH–EASTERN INDIA

By

Dr. U. SHUKLA
BOTANICAL SURVEY OF INDIA,
SHILLONG 793 001

SCIENTIFIC PUBLISHERS, JODHPUR

Bot

Published by
Scientific Publishers
5A New Pali Road
P. O. Box. 91
Jodhpur – 342 001, India

NE
584.9095416
SHU

© U. Shukla, 1996

ISBN : 81-7233-115-0

NEHU LIBRARY
Acc. N. 188223
Acc. by
Date 13/10/93
Class by
Sub. Heading by
Enter by
Transcribed by
COMPUTERISED

Typeset by
Rajesh Ojha

Printed in India

F237
1044

FOREWORD

The grasses belonging to the family Poaceae (Gramineae), although is of great economic importance to the mankind has remained fairly neglected. One of the reason for this is due to an erroneous interpretation that it is a difficult group for identification. It is true that the 'spikelet' may often require dissection of the various parts for identification but to those engaged in working on this family, its study is quite fascinating.

The most notable work on the grasses of North-east India is by N.L. Bor (1940) 'Gramineae' under the *Flora of Assam,* (Vol. V). J.N. Mitra (1958) in the *'Flowering Plants of Eastern India'* Vol. I. *Monocotyledons* also covered this region, but practically it had nothing to add to the existing knowledge, till Bor's monumental work *'Grasses of Burma, Ceylon, India and Pakistan'* was published in 1960 (reprinted, 1973). But during the last 3 decades understanding of the grasses of this region has made many strides. It was, therefore, felt necessary to reassess the gathered knowledge on this family, which will also help to complete the Monocotyledonous Flora of the North- eastern India.

The present work 'Grasses of the North-eastern India' covers approximately 475 species, most of which are illustrated with the help of about 90 plates. This work has resulted in the award of Doctor of Philosophy to the author from the University of Calcutta, Calcutta; and has been an outcome of critical study of a large number of herbarium materials deposited in the Central National Herbarium, Howrah (CAL); Botanical Survey of India, Eastern Circle, Shillong (ASSAM); Northern Circle, Dehra Dun (BSD); Forest Research Institute, Dehra Dun (DD); National Botanical Research Institute (LWG) and Central Drug Research Institute (CDRI) both at Lucknow, as well as the collection made by the author alone or jointly with his guide Dr. S.K. Jain, Ph.D., F.N.A., ex-Director, Botanical Survey of India and now Emeritus Botanist, National Botanical Research Institute, Lucknow; from various parts of this region. During course of the study historical collections namely of Gustav Mann, Masters, Clarke, U.N. Kanjilal and his son P.C. Kanjilal, Bor etc. and recent collections made by the various officers of Botanical Survey of India, Forest Research Institute, several Forest officers and students of various Universities were also available for critical study.

It is hoped that this book will be useful to all those who are engaged in the study of this family, particularly of the this region, with its proper utilization for improvement of crop, fodder, soil conservation etc.

This work is a welcome contribution by the author. It will also serve as a valuable Reference literature for years to come for the taxonomists in this country and abroad.

Shillong
25th August, 1995

Dr. V.J. NAIR
Botanical Survey of India

PREVIEW

North-east India comprising the states of Arunachal Pradesh, Assam Manipur, Meghalaya, Mizoram and Tripura and spreading over an area of more than 250,000 sq. km. is the richest region in the diversity of flowering plants in India. Out of the estimated 17000 species of angiosperms of our country, about 7000 are known to occur in this region. Of these, Grasses belonging to the family Poaceae is second only to Orchidaceae. Poaceae is an important family and the utility of members like rice, wheat, barley, maize and sugar-cane needs no emphasis. Knowledge on the occurrence and distribution of the wild relatives of these cultivated plants is an absolute necessity to put them into use to improve disease resistant and high yielding varieties. Bamboos, the arborescent grasses, play a significant role in the lifestyle of the rural community in the North-east. Out of about 150 species of bamboos in India approximately 80 are distributed in this area. Grasses are also useful in various other ways.

Bor in 1940 wrote about this family in the fifth volume of the monumental work, 'The Flora of Assam' by Kanjilal *et al.* However, over the years, grass taxonomy has progressed a lot and many earlier generic and other concepts have changed. Thanks to the intensive explorations conducted by Botanical Survey of India in various parts of North-east India, considerable amount of materials and information on grasses have accmulated in our Herbaria making it essential to have a fresh detailed study of the group. The present book is the result of such an attempt by Dr. U. Shukla of the Eastern Regional Circle of Botanical Survey of India. The work was done under the able supervision of one of our eminent agrostologists and former Director, Botanical Survey of India, Dr. S. K. Jain, FNA.

'The Grasses of North-Eastern India' deals with about 475 species of the area most of which are illustrated by 90 plates. This work is based on the critical study of vast amount of herbarium materials including historical collections of early explorers like Craib, Gallatly, Griffith, Gustavmann, Clarke, Hooker and Thomson, Kingdon Ward, Bor and Kanjilal and recent collections deposited in various Indian herbaria and can be considered quite a good account of this difficult group.

It is hoped that this work will be of great use to anybody interested in grasses.

CALCUTTA
2nd September, 1995

P.K. Hajra
Director
Botanical Survey of India

CONTENTS

INTRODUCTION

The family Gramineae had remained fairly neglected in this region, until N.L. Bor formerly a political officer and then in the Indian Forest Service, started intensive collections of the grasses in this region which resulted in the publication of the 'Flora of Assam' vol. 5 (1940). Later J. N. Mitra brought out 'Flowering plants of Eastern India' vol. 1. Monocotyledons (1958) which also covered grass flora of this area, but it had practically nothing to add to the existing knowledge.

Bor's monumental work 'Grasses of Burma, Ceylon, India and Pakistan' (1960) provided a synoptic account of the grasses, covering N.E. Region as well. This work, on one hand added knowledge gathered during the two decades, while on the other, raised several controversies regarding distribution of several species. Bor himself was aware of these discrepancies. He made some of these corrections and included them under appendices in the reprinted edition (1973).

In this work an effort has been made to bring out an updated account of the grasses of the north-eastern India. The author had an opportunity to examine the materials on which the earlier reports were based, including some of the historical collections of Gustav Mann, Clarke, Hooker and Thomson, Masters, Bor etc. as well as recent collections deposited in the herbarium of Botanical Survery of India, Eastern Circle, Shillong (ASSAM); Central National herbarium, Howrah (CAL); Northern Circle, Dehra Dun (BSD); Forest Research Institute, Dehra Dun (DD); North Eastern Hill University, Shillong (NEHU) etc. Several field trips by the author alone or with Dr. S.K. Jain, the then Deputy Director in the Eastern Circle, Shillong; in various parts of this region has helped in better understanding of the grasses. This has necessitated some changes in the descriptions of the species. To facilitate identification several species are illustrated.

In this account the species have been included, based mainly on the examined specimens. However, in a few cases names of the species that are likely to occur in the area of this work have been included on the authority of the earlier reports.

Range of flowering and fruiting period has been provided based on the field data, actually the period may some times extend before and after the period mentioned. Perennial species have spikelets more or less throughout the year and species of bamboos flower after a fixed cycle of years; in some species flowering period may extend for about 3 years. Generally flowering of bamboos is considered ominous, in Mizoram it is related with famine. Flowering behaviour of the bamboos needs further, thorough study.

Distribution of each species in this region, India and in the world has also been provided. The term North-Eastern India has been used more or less for the former Assam.

The members of this family Gramineae (Poaceae) are commonly referred as grasses. Importance of the grasses are many-fold for the mankind. There are historical evidences that most of the world's civilizations developed around the regions of grasslands. In fact it may be referred that the present level of civilization and development are dependant on abundance and wide spread distribution of the grasses. Not only human population but even the very survival of the animal kingdom is dependant on the grasses. Herbivorous animals are directly dependant whereas the carnivorous animals are indirectly dependant on the grasslands.

From the pre-historic times man has been dependant on the grasses for food, fodder, shelter and medicines. Some of these economic uses are briefly discussed. This is followed by discussions on area of this work, topography of the area, history of botanical works in this

region, history mainly of Indian Agrostology, general vegetation, grasslands of this region, phytogeographical affinities, materials and method and list of abbreviations used.

This is followed by taxonomic treatment of this family, bibliography and the index.

ECONOMIC IMPORTANCE

Food : Several species are cultivated for their edible grains such as *Avena sativa* (oats), *Coix lacryma-jobi, Digitaria compacta, Echinchloa frumentacea, Eleusine coracana, Hordeum vulgare* (barley), *Oryza sativa* (rice) which forms main food in this region, *Panicum miliaceum* (common millets), *Paspalum scrobiculatum, Pennisetum americanum* (pearl millets), *Secale cereale, Setaria italica* (the millets), *Sorghum* spp. (giant millets); *Triticum aestivum* and *T. polonicum* and, *Zea mays* (maize) etc.

Several other species such as *Bambusa tulda, Dactyloctenium aegyptium, Ischaemum rugosum, Echinchloa colonum, E. crus-galli, Oryza rufipogon, Sacciolepis indica* and *Setaria pumila* are also known to provide food at the time of scarcity. Young shoots of several species of bamboos are used as vegetable and are made into pickles.

Fodder : Generally more leafy species are preferred by the stock, though *Chrysopogon aciculatus* with sharp callus and *Heteropogon contortus* with sharp awns are also eaten in young stage, before flowerings, by the cattle.

Species considered good for fodder are *Agrostis myriantha, Andropogon ascinodis, Apluda mutica, Apocopis paleacea, Axonopus compressus, Arrhenatherum elatius, Brachiaria distachya, B. mutica, Bromus catharticus, B. ramosus, Cynodon dactylon, Dactyloctenium aegyptium, Dichanthium glabrum, D. pertusum, Digitaria* spp. *Echinochloa colonum, E. crus-galli, Eleusine indica, Hackelochloa granularis, Hemarthria compressa, Ischaemum indicum, Oryza meyriana* sub sp. *granulata, O. minuta, Rottboellia cochinchinensis* and *Setaria* spp.

In addition a number of species belonging to the following genera introduced in Shillong around 1936 are well established : *Agrostis, Anthoxanthum, Bromus, Cynosurus, Festuca, Helictotrichon, Holcus, Lolium, Panicum, Pennisetum* etc. Bor (1960) however, remarks that since there are a large number of indigenous grasses which are nutritious as well as palatable, there is no need to introduce the exotics. This observations, to some extent, has also been supported by various workers of the Indian Council of Agricultural Research (I. C. A. R.), Barapani, Shillong.

Building materials : Various species of the bamboos provide building materials. Slender culms of *Chimonobambusa khasiana* are commonly used for making walls in Shillong. One layer of these are placed between the wooden squares of the walls and are plastered on both the sides. In some of the states e.g. Mizoram, some parts of Meghalaya etc. most of the houses are entirely built of the bamboos for which thin-walled culms of *Melocanna baccifera,* after splitting, is commonly used. The culms of *Arundo donax, Phragmites karka, Themeda arundinacea, T. villosa* and *Imperata cylindrica* are commonly used.

Essential oils : Several species of *Cymbopogon, Dichanthium* and *Vetiveria* yield oils on steam distillation. A few species of *Cymbopogon* are under trial by the Forest Department, Meghalaya. Those oils which contain high proportion of Citronella are used for synthesis of certain complicated organic compounds e.g. Menthol, whereas those with high Geraniol and low Citronella are used as perfumes in soap and other preparations and extraction of aromatic isolates. In *Vetiveria* the roots contain aromatic oil,

these are used for the manufacture of scents and making curtains of 'khas-khas' for use during summer. Aromatic species of *Dichanthium* probably have not been commercially utilised.

Anthoxanthum odoratum a quite common grass in Ward' s Lake and in other wet patches in Shillong and *Melinis minutiflora* introduced about in 1940 in the Khasi hills near Nongpoh; Garo hills, Meghalaya and Manipur also have a characteristic odour. The latter is said to have an insect and snake repellent property. But apparently these also have not been tried. A recent search to locate *Melinis* in these states proved futile. Apparently this could survive for a few years only.

Paper industry : *Arundo donax, Heteropogon contortus, Saccharum* spp., *Phragmites karka, Themeda arundinacea* and *T. villosa* yield very good material for paper pulp. *Dichanthium glaburm, Saccharum ravennae, Sclerostachya fusca* produce poor pulp, whereas *Desmostachya bipinnata, Imperata cylindrica* and *Vetiveria zizanioides* in mixture with the bamboos and *Eulaliopis binata* are being satisfactorily used in the paper industry. *Saccharum officinarum* is used for making inferior quality of wrapping paper.

Lawn grasses : *Cynodon dactylon* is an ideal lawn grass for lawns, turfs, tennis lawn and Golf' s green. Among other grasses *Axonopus compressus, Chrysopogon aciculatus, Imperata cylindrica* and *Oplismenus burmannii* may be used for similar purpose, with regular cutting to check formation of inflorescence. In Shillong having a very heavy rain fall, *Axonopus compressus* is a very common grass in the lawns and is a chief constituent of the Golf Link and Polo Ground. *Pennisetum clandestinum* (Kikuyu grass) with the spikelets concealed within the subtending leaf-sheath and long creeping habit is an extremely common grass on exposed road sides and in the lawns.

Medicinal grasses : A number of grasses occurring in this region have medicinal properties (Shukla & Das, 1981), some of these have been briefly discussed here:

Desmostachya bipinnata : The plant is used in dysentery and menorrhagia. It is also stated to be diuretic.

Saccharum officinarum : Culms and the roots are used as diuretic, cooling agent and aphrodisiac. It is also said to be of use in the intestinal trouble, anemia, erysepelas and leprosy.

Setaria italica : The grains are said to be diuretic, astringent and externally useful in rheumatism.

Thysanolaena maxima : Decoction of the roots is used as a mouth wash during fever.

Ornamental grasses : *Phalaris arundinacea* var *picta* is a common grass cultivated in Shillong for its leaves striped purple or white and green. Bor (1940) mentioned that this variety has reverted to its wild form with uniform green leaves, but it has not. Similarly *Arundo donax* var. *versicolor* for its striped leaves is occasionally met with in Gauhati and perhaps may be cultivated elsewhere also. Silvery panicles of *Saccharum* spp. in its natural colour or after dyeing is also used for decoration. *Briza maxima* with drooping, large spikelets is also put to similar use and was once collected in Shillong.

Miscellaneous uses : In addition to these, several species are put to various other uses such as :

Brooms : Panicles of *Thysanolaena maxima* are made into brooms. This is an important article of commerce in this region.

Ropes : Strong ropes are made of *Eulaliopsis binata* and *Desmostachya bipinnata.*

Brewery : Grains of *Eleusine coracana* and 'involucres' of *Coix lacryma-jobi* are used for this purpose. *Oryza sativa* also has been in use for making good qualities of wines.

Ornaments and rosary : The involucres of *Coix lacryma-jobi* are frequently used for making necklaces, ear-rings in Nagaland and are also used as beads to make rosary etc. Aromatic leaves of *Cymbopogon* spp. are made into bangles in several places.

Rodent repellent : Bristly inflorescence of *Setaria italica* and *S. verticillata* are effectively used to protect grains from rodents.

Musical instruments : Hollow culms of *Arundo donax* and *Phragmites karka* are used for making flutes.

Hindu rituals : *Desmostachya bipinnata* and *Cynodon dactylon* are considered to be sacred and are used in many Hindu rituals.

Cultural importance : The bamboo dance of Mizoram is very famous in which long sticks of bamboos are held at both the ends and are struck with each other rhythmically, the dancers mostly young girls dance between these sticks. At slight miss of rhythm there is a risk of breaking the ankles of the dancer.

Soil binder : Hilly slopes in this region are practically covered all over with *Imperata cylindrica.* Its rhizomes are very effective to check the soil erosion. Similarly root systems of several species act as a good soil binder for the surface they cover.

Water carriers : In several places thick culms of several species of bamboos are used for carrying water.

In addition to these uses, bamboos play very important role in the economy of this region. Several articles of daily use such as baskets, mattings, furniture, ladies purses and many other things are made of bamboos. Culms of *Arundo donax* and *Phragmites karka* are also put to some of these uses.

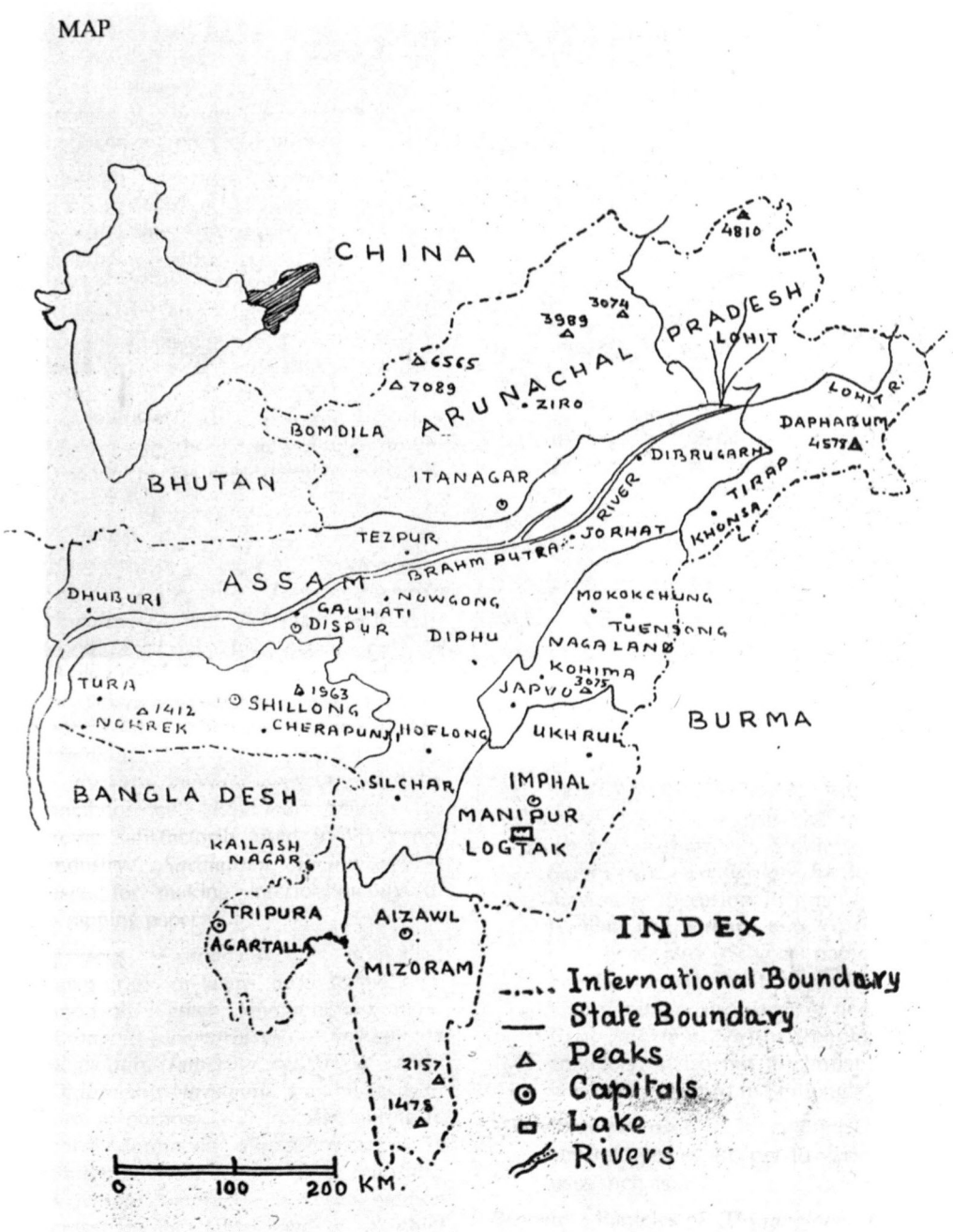
In Mizoram an interesting phenomenon has been observed related with the flowering of bamboos. It has been observed that *Bambusa tulda* periodically flowers gregariously after about 50 years and *Melocanna baccifera* flowers after a cycle of about 30 years, which is related with the rapid increase in population of rodents, these in turn destroy all the available food grains thus causing famine. Gregarious flowering has been reported in 1991 from Arunachal pradesh also, the species is yet to be ascertained.

Flowering of the bamboos, its relation with increase of the rodent population, its means of checking etc. need further detailed study.

AREA OF THE WORK

The north eastern region of India, dealt in this work lies approximately between 21°.80' -29°.50' N latitude and 89°56 -97° 40' E longitude, has an area of approximately 2,50,000 sq km (97,660 sq miles). It is bounded in the north west by Bhutan, in the north by China, in the east and south east along the entire length by Myanmar, in the south and south west by Bangla Desh and is connected with other parts of India through a narrow neck near Jalpaiguri between Bangla Desh and Nepal.

The area as defined here more or less coincides with the area covered under the former Assam in the pioneer work 'Flora of Assam' Vols. 1-4 by Kanjilal *et al.* (1934-1940) and Vol. 5 by Bor (1940), excluding Sylhet and some parts of Surma valley which now form parts of Bangla Desh (formerly called East Pakistan). This region now comprises the following 7 states, their capital and district head quarters have been indicated in parenthesis :



Maps of N.E. India

Arunachal Pradesh :– (formerly called north East Frontier Agency or NEFA; capital at Itanagar). This part also described as 'the land of the dawning sun' lies approximately between 26°30' -29°28' N and 91°25' -97°24' E. It is divided into Kameng (Bomdi La) Subansiri (Ziro), Siang (Along), Lohit (Tezu) and Tirap (Khonsa), districts. The entire region is mountainous rising to over 7000m in the north-eastern parts.

Assam :– (Capital at Dispur, Gauhati)- Literally meaning 'uneven' refers to the uneven landscape. It lies approximately between 24°10' -28°20' N and 89°99' -96°01' E. The state is divided into Cachar (Silchar), Darrang (Tezpur), Goalpara (Dhubri), Kamrup (Gauhati), North Cachar Hills (Haflong), Nowgong (Nowgong), Sibsagar (Jorhat), N. Lakhimpur (N.Lakhimpur), Dibrugarh (Dibrugarh), Karbi-anglong (Diphu), Kokrajhar (Kokrajhar), Karim ganj (Karim ganj), Hailakandi (Hailakandi), and Nalbari (Nalbari).

Manipur (Capital at Imphal):– The state lies between 23°47' -25°4' N and 93°61' -94°48' E. It is divided into Central (Imphal), East (Ukhrul), North (Senapati), South (Churachandpur), West (Tamenglong) and Tengnoupal (Chandel), Highest peak is Ukhurul (2666m.).

Meghalaya (Capital at Shillong):– Means 'abode of clouds'. It lies between 25°30' -26°0' N and 89°99-92°88 E. It is divided into East Khasi hills (Shillong), Ri-bhoi (Nongpoh), West Khasi hills (Nongstoin), East Garo hills (Williamnagar), West Garo Hills(Tura), Baghmara (Baghmara) and Jaintia hills (Jowai). Important peaks are Shillong peak (*ca* 2000m) Nokrek peak (1468m) and Tura Peak (1300 m).

Mizoram (Capital at Aizwal) :– It is also described as 'the land where bamboos flower'. It lies approximately between 22°0' -24°5' N and 92°5' -93°0' E. The highest peak is Blue Mountain (2300m).

Nagaland (Capital at Kohima) :– It marks the eastern limit of this region. It lies approximately between 25°13' - 26°32' N and 93°-94°20' E. The state is divided into Kohima, Mokokchung, Mon, Phek, Tuensang, Wokha and Zonhebuto.

Tripura (Capital at Agartala) :– It lies approximately between 22°56' -24°32' N and 91°10' -92°22' E. It is divided into North Tripura (Kailash nagar), south Tripura (Udaipur)and West Tripura (Agartala).

TOPOGRAPHY OF THE AREA

Topography of the area has been discussed in detail by Rao (1974). Topographically most of the area in this region is hilly terrain. Important hill ranges are parts of eastern Himalaya, Naga hills, Manipur hills, Assam range and Lushai hills etc.

The eastern Himalayas commencing from the eastern Nepal comprises Aka, Abor, Mishmi or Miju and neighboring hills of Arunachal Pradesh. This is a mountainous region, some of the north western parts rising to over 7000 m, which are perennially snow-capped; there are also deep gorges and some parts in the foot hills are level plains. Southern offshoots of the main Himalayan ranges separating India and Myanmar are called Patkai, Jaintia, Khasi, Garo and Lushai ranges, the larger areas of the hills forming eastern and south-eastern borders include Naga hills, Manipur hills and Lushai hills, the highest peak being Japvo (3275 m), Nagaland. A series of hills in the north east form a barrier between the upper Brahmaputra Valley and western boundary of China.

Assam comprises Surma and Brahmaputra valleys, both surrounded on the north, east and and south by the hills. Brahmaputra valley is an alluvial plain about 750 km long and 80 km wide. It is more or less

of uniform width almost up to the southern sector of Brahmaputra river except where Mikir hills project from Assam range.

Assam range separating the 2 valleys almost runs east-west at right angles to the Burmese system, westwards near Tura it rises to *ca* 1200m, in the east near Shillong the hill rises to *ca* 2000m with a general northerly slope. Garo hills form western limit of the Assam range, it rises abruptly from the plains on the south and attains a maximum elevation near Nokrek (1412m) in the east of Tura. On the north there is a succession of hills towards Brahmaputra. Khasi hills gradually rise in the north from the Assam plain by a succession of low hills. In the south the hills rise abruptly from the level plain to 1200 m. The Jaintia hills slope somewhat gently to the plain than the Khasi hills. The southern and central parts of the area constitute the Shillong plateau (1200-2000 m) also known as Meghalaya. The steep southern edge of the plateau is straight and rises to 1500 m, Cherrapunji located in this part enjoy the heaviest rainfall in the world. The Lushai hills rise to a mean elevation of 1200m in the west and 1600 m in the east and at places even to 2400m (Blue mountain). These are the southwardly continuation of the hills forming the Patkai range. The Naga hills is a region of narrow hills; Japvo peak situated a little south of Kohima rises to 3275 m, the Barail range extends into this area from the west.

Range of the hills in Manipur follow a north-south trend. The central valley is about 48.3 km long and 32.2 km wide.

In Tripura, there are six principal ranges increasing in elevation towards the east, north and south. Some of these are Jampai (Betlingshib peak, 975.36 m, Jampai, 566.2 m)and Atharmura (436.9 m).

Rivers : Mighty Brahmaputra about 2703 km long, after receiving tributaries like Siang, or Dibang or Sibang, Lohit, Kameng, Manas and Subansiri in Arunachal Pradesh enters Assam near Dibrugarh and flowing through the entire length of the state for over 750 km, following a general westwards course, after receiving Digaru and Singra enters Bangla Desh near Dhubri to join Meghna. The river has numerous islands and is bordered on either sides by the marshy lands covered with tall grasses. Further inland the level rises and is extensively cultivated. In the western part of Meghalaya main river is Someswari, which originates near Tura and join Kangsa. Important river in Nagaland is Davang. Southern rivers from Manipur, Mizoram and Nagaland join Surma and Meghna rivers of Bangla Desh and Chindwin and Irawadi of Myanmar. Thoubal, Iril and Imphal originate from north and northwest of Manipur, eastern hills have numerous streams which drain into Yu and finally into Chindwin of Myanmar. In the western hills of Manipur the main river is Barak and its tributary Irong. Rivers of Tripura such as Khowai, Dolei, Manu, Juri and Lungai flow northward, Gomati following a western course joins Meghna and Fenny and Muhari pours its water into Bay of Bengal.

Lakes and bhils : There are numerous lakes and bhils (jheels) particularly in Assam. Logtak is the largest natural, perennial lake in Manipur. It has got a 'floating island' Keibul-Lamjao which is inhabited by an endemic species of dear the 'Brow-Antlered Dear'.

HISTORY OF BOTANICAL WORKS IN THE N.E. REGION

Botanical collection in this region was initiated by the active interest of Francis Jenkins (1793-1855), agent to the Governor General of Gauhati, who himself and through his collectors gathered plant materials along the Brahmaputra valley mainly in and around Gauhati and deposited them in the Sibpur Herbarium, now called Central National

Hesrbarium (CAL). F. Buchnan Hamilton during his survey of Bengal for collections of plants stayed at Gauhati in 1808 and gathered some specimens form there. After that John Mack and his wife (1826) collected plants from the Khasi hills and forwarded them to Sir William Hooker; at about the same time Wilcox (1827) gathered plant materials from the Mishmi hills.

The earliest to write about the plants of this region seems to be F. Buchnan Hamilton (1820) and Roxburgh (1820, 1832).The latter used to receive chiefly the ornamental plants for introduction in the Botanical Garden, Sibpur (Howrah), from 'Sylhet Mountains' which in fact were from the Khasi hills.

Robert Bruce (1823) while trekking up the Brahmaputra river came to know that Singpho used to prepare a local tea. Later David Scott (1826), Governor General' s Agent obtained a leafy twig from Manipur which was a local source of tea. N. Wallich, the then Superintendent of the Botanical Garden identified it as wild tea. This led East India Company to organise the 'Assam Tea Delegation' in 1835 to explore the possibility of establishing tea industry in this region. With the appointment of 'Tea Delegation' started the main history of the botanical works in this region.

Wallich, Griffith and Mc Cleland entrusted with the establishment of tea in Assam, started their journey on 31st August 1835 from, Hooghly by boat. They passed through the jheels of Sylhet to Terya Ghat, collecting plants on their way, in order to get acquainted with the flora of this area, along a cross section from Sylhet on one end to the Mishmi hills on the other. Later W. Robinson described the story of wild tea as well as the flora of Assam. About the middle of the 19th century, Sir J.D. Hooker and T. Thomson (1854) collected approximately 3000 plants from the Khasi hills, Jaintia hills and Sylhet and another about 1000 from the plains.

This infused greater interest in several other workers of that period. John White Masters, a sub Assistant under Francis Jenkins made collections along the Brahmaputra river up to Sadiya and in the Naga hills, but probably the most enthusiastic collector was C.B.Clarke, who practically traversed the entire area, several times on foot, making extensive collections. Among other collectors were Gage (1899, 1901) in the Lushai hills; Klein in Cachar; Falconer in the Khasi hills and J. Simon in the Assam valley, Mikir hills and the Khasi hills. Simon's earlier collections were dispatched to Sibpur Herbarium and the later ones to Sir J. D. Hooker. Booth was gathering in the Daphla hills at the south-east border of Bhutan and Griffith in the Khasi hills (Khasiyah) and Bootan mountains during 1837-1838. However, Gustav Mann the first Conservator of Forests in Assam was the first person to begin a systematic collection of plants from the plains of Assam and Khasi hills during 1870-1885 and preserve them in Shillong.

It is seen that at that time references to the localities were not precise, the plains were referred as Assam, plains of Brahmaputra valley or Surma valley and the hilly regions as Garo hills, Jaintia hills, Khasi hills and so on. It is also noticed that the plants referred to from Sylhet-plains or Sylhet mountains and Pundua hills generally belonged to the Khasi hills.

Dawn of the 20th century saw vigorous activity for plant exploration in this region. A. T. Gage (1901) published a tour report of south Lushai hills, Mizoram; D. Prain covered the Naga hills. I.H. Burkill (1925) was a major contributor to our knowledge of the distribution of plants based on his collections from Abor hills in Siang district, Arunachal pradesh and parts of the Khasi hills. Mrs. N.E. Parry (1924-1928) gathered plants in the Garo hills; Lushai hills (Mizoram) were covered by Rev. W.J. Wenger, Brother Godfray, R.H. Lorrain and C.E.C. Fischer during 1924-1932. These collections were studied and published in the excellent account of the plants of Lushai

hills by Fischer (1938). While Peal was exploring Sibsagar district, Assam; Carter (1921) published an account of Lakhimpur district. F. Kingdon Ward had undertaken several explorations in the Mishmi hills (1929) as well as in Lohit, and Balipara F. T. and the Khasi hills during 1926-1950 and parts of Manipur (1949, 1952). Watt (1890) also published on the forests of Manipur.

However, the idea of presenting a comprehensive flora of this region was first conceived by Sir Archdale Earle, Chief Commissioner, under whose patronage U.N. Kanjilal vigorously added to the earlier collections. These were housed in a separate room in Assam Secretariat which came to be known as Assam Forest Herbarium. But he died on 25th October 1928 much before the publication of the first volume of Flora of Assam (1934). However, his huge collections, careful field notes and drafts were of immense help to his successors. P.C. Kanjilal succeeded his father, who expanded the collections to 40, 000 with the active support of the workers like G.K.Deka, S.R. Sharma, D.N. Pal, R.N. De, D.N. Kalita, B.B. Syam and several others. A. Das took over the charge of publication of Flora of Assam in 1931 which was published in 4 volumes (1934-1940), he was assisted by C.S. Purkayastha and R.N. De. N.L. Bor, who had been to Nagaland and Aka hills as political officer, had an unusual interest in grasses. He made extensive collections in several parts of Arunachal Pradesh, Assam, Manipur, Meghalaya and Nagaland during 1936. He brought out volume 5 of the Flora of Assam (1940) containing an account of the grasses; other publications of that period being that of Bor (1938, 1942) and Biswas (1941-1943). Other contemporary collectors have been sister Dogmar of Oxford Mission who collected in Khasi hills and L.L. Read, an Agriculture Inspector, in Govt. Fruit garden, Shillong, who collected in Shillong. Most of the collectors used to send their materials to European Herbaria and occasionally to Calcutta Herbarium now referred to as Central National Herbarium or C.N.H. or CAL where a small percentage of the former lot were gifted back. I.H. Burkill (1960) has done a great service in chronologically arranging history of botany in India including this region.

Since taking over of the Assam Forest Herbarium in 1956 Botanical Survey of India planned a thorough Survey of plants. Periodical explorations are being organised in several unexplored or under explored areas. R.S. Rao and G. Panigrahi have surveyed principally in the Himalayas. Naik and Panigrahi (1961) described collections from Subansiri. Panigrahi and Joseph (1966) have enumerated plants of Tirap. Deb (1961) has studied the flora of Manipur and later of Tirap (1971-1974). Botanical Survey of India has also taken up writing of the Monocotyledonous flora of this region. With this view in mind D.M. Verma has completed Cyperaceae of Assam (1982) and accounts of several other families have been published by A.S.Rao and D.M. Verma (1969–1979), and orchids of Meghalaya by S.K. Kataki (1986). Flora of Jowai has been completed by N.P. Balakrishnan (1982-1983) and that of Nongpoh and surrounding area by J. Joseph (1982).During the period of S.K.Jain, the then Deputy Director, Eastern Circle. Shillong and later Director, Botanical Survey of India, explorations were intensified in Arunachal Pradesh, Manipur, Meghalaya and Nagaland. The author also visited some parts of Arunachal Pradesh, Manipur, Meghalaya and Mizoram during 1971-1976 with him as well as independently. The present work is also an effort towards completion of the Monocot flora of this region. In the last few years several papers have been published by the various officers of the Botanical Survey of India, including the grasses of this area, such as Shukla (1978), Neogi & Jain (1979), Jain & Shukla (1979); Prakash, Shukla & Jain (1979); Shukla & Doli Das (1981) etc.

In addition to the studies made by the Botanical Survey of India, this region has attracted botanists from Forest Research Institute, Dehra Dun, a few students from

Chandigarh University, North Eastern Hill University, Shillong etc. as well as botanists from abroad.

A BRIEF CHRONOLOGICAL ACCOUNT OF THE BOTANICAL WORKS IN THIS REGION

History of the botanical works seems to have started in this region in the later part of the 18th century under the active interest of Sir Francis Jenkins (1793-1855) Agent to the Governor General of Gauhati. This was followed up by several later collectors. But the main history of botanical collections started with the appointment of the 'Tea Delegation' in 1835. All these collections formed the basis of 'Flora of Assam' Vols. 1-4 by U.N. Kanjilal and his co-workers; and Vol. 5 by N.L. Bor (Gramineae, 1940). All these and collections by subsequent collectors chiefly the Forest Officers were preserved in the Secretariat Building, Shillong. Since the revival of the Botanical Survey of India, with the Head Quarters at Calcutta and establishment of Eastern Circle, Shillong; the Herbarium of the Forest Department was transferred to this Circle in 1956.This herbarium now known as 'Kanjilal's Herbarium', Herbarium of Botanical Survey of India, Eastern Circle or referred as 'ASSAM'. Since then various officers of the Botanical Survey of India, Eastern Circle and those of Itanagar have undertaken systematic and thorough explorations with the aim of completing state floras of this region and finally aiding the completion of the flora of this country.

An effort has been made here to chronologically arrange some of these important works. Asterisks mark against year indicate year of publication of that work.

Year	Name of the collector	Area of work
	Jenkins, F. (1793-1855)	Gauhati, along Bramhaputra
1808	Buchnan, F.	F. Gauahati(on way to Bengal via Patna)
1826	Mack John and his wife	Khasi hills
1827	Wilcox	Mishmi hills.
1835	Griffith, Wallich, N. and Mc Clelland (Tea Deputation)	Sadiya to Mishmi hills.
1854	Hooker, J.D. & Thomson, T.	Khasi hills
1883	Watt, George	Manipur.
1889 *	Clarke, C.B.	Kohima (Nagaland), Manipur.
1890	Watt, George	Casual collection of a few species.
1899	Gage, A. T.	Chittagong to Lungleh
1901 *	----------	S. Lushai hills.
1906-1907	Meebold, A.	Manipur.
1911-1913	Burkill, I.H.	Abor hills, Khasi hills (published 1925)
1914-1921	Deb Burman, P.B.	Tripura
1921 *	Carter, H.G.	N. Lakhimpur.
1924	Mrs. Parry, N.E.	Garo hills, Lushai hills. (published 1932).
1925 *	Burkill, I.H.	Abor hills.

Year	Name of the collector	Area of work
1926	Ward, Kingdon	Lohit Dist., Sadiya.
1924-1932	Wenger, W.J.L.; C.B. Clarke Fischer, C.E.C.	Lushai hills.
1927-1928	Ward, Kingdon	Mishmi hills.
1933	----------	Arunachal Pradesh (former N.E.F.A.)
1936-1940*	Kanjilal, U.N. *et al.*	N.E. India (former ASSAM)(Flora of Assam, Vols.1-
1938	Bor, N.L.	N.E.India(former Assam)
1938	----------	Aka hills.
1938 *	Fischer, C.E.C.	Mizoram
1938	Ward, Kingdon	Balipara F. T.
1940 *	Bor N.L.	N.E. India(Assam; Fl. Ass. Vol. 5)
1941	Biswas, K.	Aka hills, Balipara, F.T. Tripura.
1942	Bor, N.L.	Shillong Plateau.
1946	Ward, Kingdon	Khasi hills
1946	----------	E. Manipur.
1957-1960	Deb, D.B.	Manipur. (pub. 1961.)
1959	Srinivasan, K.S.	Bomdi La.
1961 *	Deb, D.B.	Manipur.
1961 *	Naik, V; G. Panigrahi	Subansiri.
1965 *	Rolla Rao, S.; J.Joseph	Siang
1966 *	Panigrahi, G; J.Joseph	Tirap
1966 *	---------; V.M. Naik	Tirap
1966 *	Rao, A.S.; L.L.Rabha	S.Kamrup
1969 *	Sahni, K.C.	Kameng
1971, 1976*	Deb, D.B.; R.M.Dutta	Tirap.
1978*	Shukla, U.	E. India
1974-1976	Shukla, U.	parts of Meghalaya, Manipur, Assam, Mizoram, Arunachal pradesh.
1975	Jain, S.K.; U. Shukla	Arunachal Pradesh, Manipur, Meghalaya.
1976*	-------, ----------	Manipur (grasses)
1976*	--------; B. Neogi	Assam.
1978*	Shukla , U; *et al.*	Mizoram
1979&*	----------.A.K.Baishya	Manipur
1981*, 1982*	Joseph, J .	Nongpoh

188223

Year	Name of the collector	Area of work
1981*, 1983*	Deb. D.B.	Tripura
1981*, 1983*	Balakrishnan, N.P.	Jowai
1982-1985	Different workers	Namdapha project
1983*	Shukla, U.	N.E.India (endemism)
1985	Dutta, R.M.	Garo hills.
1986 *	Haridasan, K; R.R.Rao	Meghalaya.
1986	Baishya, A.K.	Khasi hills, Siang, Mizoram, Assam.
1986 *	Kataki, S.K.	Meghalaya (Orchids of)
1986	Hynniewetta, T.M.	Lohit Dist., Nagaland
1987	Vaish, U.S.	B.S.I. compound, Barapani
1987	Dutta, R.M.	Garo hills.
1988	Singh, D.K.	Mizoram
1988	Dutta, R.M.	Mizoram
1988	Baishya, A.K.	Assam
1988	Chauhan, A.S.	Manipur, Namdapha (proposed Biosphere Reserve, Arunachal Pradesh).
1988	Shampru, R.	Jaintiapur.
1988-89	Shukla, U.	Garo hills, Khasi hills

NORTH-EASTERN HILL UNIVERSITY LIBRARY Date.....

Recent intensive explorations are aimed to bring out state floras of Manipur, Mizoram and Assam in the near future.

HISTORY OF INDIAN AGROSTOLOGY

Cynodon dactylon., Desmostachya bipinnata and bamboos have been in use in Hindu ceremonies since long and species of *Cymbopogon* and *Vetiveria* having medicinal properties have been mentioned in the Indian works of 17th and 18th centuries. However, taxonomic treatment of the grasses have been attempted from the 19th century.

An early work on the grasses of Indian sub continent was by Griffith (1834), who described grasses of Jheels of Sylhet (now in Bangla Desh). Conspicuous bamboos caught the attention of Sleeman (1839), Kurz (1878), and Gamble (1896). Stapf (1906), Furguson (1881), Symonds (1886), Duthie (1883, 1886, 1888, 1893), Coldstream (1889) and Lisboa (1896) collected, studied and described grasses of different regions of India and Sri Lanka, Nineteenth century closed with the publication of monumental work the 'Flora of British India' vol. 7 (Gramineae by Hooker & Stapf), 1896–1897.

This was followed by the publications of 'Bengal Plants' (Prain, 1903) 'Flora of Bombay, II (Cooke, 1908)', 'Botany of Bihar and Orissa' (Mooney, 1939, 1950), 'Flora of Madras Presidency' (Gramineae pt. x, Fischer, 1934).

Intensive studies of the grasses were made by Blatter and Mc Cann, their work resulted in the excellent account of the grasses

of Bombay (1934).Achariar and Mudaliar (1921) studied the grasses of Madras and the adjoining areas and published the grasses of South India, Jacob (1938, 1940-1942) contributed to the knowledge of Chittor, Arcot and Travancore; Bor made extensive collections in Assam, Uttar Pradesh and the Himalayas and published grasses of Assam, (Flora of Assam, vol.5. Gramineae, 1940), Common grasses of Uttar Pradesh (1941) and 'Grasses of Burma, Ceylon, India and Pakistan' (1960, reprinted 1973). Stewart (1945) published an account of.the grasses of the N.W.India. Raizda, Jain and Bhardwaja (1961, 1964) have published 'The grasses of the Upper Gangetic Plain' which is a supplement to the 'Flora of Upper Gangetic Plain' by Duthie . Kapadia (1945), Desai & Murty (1950), Majumdar (1956) have brought out accounts of the grasses of Junagadh (Gujarat), Dharwar (Kathiawar), 24 Paraganas (West Bengal) respectively. Patil (1960) provided a key to the grasses of Lucknow. Tewari (1954-1955, 1961) and Shukla & Panigrahi (1967) gave accounts of the grasses of Madhya Pradesh which were precursors to the 'Grasses of Madhya Pradesh' by Roy, (1984). Patunkar (1980) published 'Grasses of Marathawada' (Maharashtra). Several additions and name changes in this family have been published by Shukla and Jain (1979); Ved Prakash *et al* . (1979); Uniyal (1986); Singh (1986); Karthikeyan *et al* . (1989).The latter have brought out a check-list of the Monocots with updated nomenclature. Choudhury (1959-1960) studied the grasses of W. Bengal. Jain and his co-workers (1961 onwards) have published numerous papers on the Indian grasses including bibilography of the family Graminease (1961, 1972) and 'Grasses of Bengal, Behar and Orissa' (1975). They have also revised genera like Cynodon (1967), Arthraxon (1972), Manisuris (1970) and Anthoxanthum (1975). Recently Singh et al. (1976) have published the grasses of Karnataka state and Majumdar (1980) published classification of the Indian grasses. Several workers are presently engaged in the study of this family.

GENERAL VEGETATION OF TIIE AREA

On account of its varied climate, topography and geographical locations bordered by China, Myanmar and Bangla Desh, vegetation and flora of this region is quite interesting, having some migrants, indigenous and endemic elements in its composition. However, it is interesting to note that among grasses alone about 55 species confined to Myanmar, quite adjacent to this area and several species occurring in West Bengal have not yet been able to migrate to this region. Bor (1940) has stated that about 10 species are likely to be found in this area; they are yet to be collected .

An interesting feature of the flora of this area, as pointed out by Sir J.D. Hooker (1854), is that some of the species common in the Western Himalayas at about 3000 m make their appearance at about 2000 m in the Khasi hills and again they occupy about 3000 m in Nagaland.

Vegetation of this area can be divided into the following types :

ALPINE TYPE

These are found in parts of Arunachal Pradesh between 4000-5000m attitude. Species found are shrubby *Rhododenduon* and among herbs are the species of *Polygonum, Primula, Saussurea, Saxifraga* and *Sedum* etc.

SUB ALPINE TYPE

These occur between 3300-4000 m and are charecterised by the presence of *Abies spectabilis, Cupressus torulosa, Juniperus recurva, Larix griffithiana, Pinus wallichiana. Taxus baccata* and *Rhododendron* spp. this type is found in some parts of Arunachal Pradesh and Nagaland.

TEMPERATE TYPE

These occur between 1800-2000 m altitude in Arunachal Pradesh, Manipur, Meghalaya and Nagaland. These are dominated by *Rhododendron* spp., conifers and oaks.

SUB TROPICAL TYPE

These occur between 900-2000 m in Arunachal Pradesh, Manipur, Meghalaya and Nagaland and are dominated by *Actinodaphne obovata, Alnus nepalensis, Bauhinia variegata, Bytneria aspera, Callicarpa arborea, Castanopsis indica* etc. and shrubs and under-shrubs of *Agapetes auriculata, A. buxifolia, Artemisia vulgaris, Camellia caduca, Cotoneaster bacillaris* etc. among the herbs are *Anaphalis* spp. *Vicoa* spp., *Campanula colorata, Plantago major* and several others.

TROPICAL EVERGREEN OR SEMI EVERGREEN TYPE

These are generally found in the rain forests in the foot hill up to 1000 m and are represented by tall trees like *Altingia* spp., *Amoora wallichii, Artocarpus chaplasha; Bischofia javanica* and *Dillenia indica* etc. Shrubs like *Abroma angusta, Ardisia humilis, A. undulata,* and *Clerodendron* spp., undergrowths, however, are very poor.

GRASSLANDS OF NORTH-EASTERN INDIA

The term grassland is applied to a landscape dominated by the grasses. Champion (1936) doubted the existence in India of any example of climax grassland, yet the grasslands are very common in India and may be very stable preclimax under the influence of fire and grazing. Bor (1942) considered that the climate in this country is either a forest climate or a desert climate. Whyte (1957) also expressed that there is hardly any natural grassland in India and certainly none in the forests but the existing grasslands are not wholly artificial either. Misra (1959) also stated '.....now all the ecologists agree that apart from the high Himalayan meadow there is no climatic climax of grassland in India' . According to Whyte (1968) the grass cover in India is primarily governed by the climatic factors and chiefly by latitude. Later Whyte (1974) remarked that the monsoon grasslands occurring in a forest climate may be called tertiary communities to distinguish these from the secondary communities constituted by the shrubs and shrub-tree complex. In an indirect way these grasslands owe their existence to the human activities.

The grasslands in this region may be classified into the following types :

TEMPERATE ALPINE TYPE

These occupy beyond 1500 m altitude in Arunachal Pradesh, Manipur, Meghalaya and Nagaland and the chief constituents are *Agrostis filipes, A. myriantha, Andropogon tristis, Chrysopogon gryllus, Dactylis glomerata, Danthonia jacquemontii* and species of *Festuca* and *Poa.*

SUB TROPICAL TYPE 'A'

Dominance of Phragmites-Saccharum-Imperata : This is found in Bramhaputra Valley, parts of Manipur and Tripura. Whyte (1968) maintains that this is distinctly a sub-tropical type. In low rainfall region the common species are *Desmostachya bipinnata, Imperata cylindrica, Phragmites karka, Saccharum arundinaceum,* and *S. spontaneum* etc.

Grass cover of this type is subjected to cutting and burning which exposes the habitat to the process of desiccation; in the swampy areas the dominant species is *Phragmites karka.* The other members of the comparatively undisturbed *Phragmites* habitat are *Arundinella decempedalis, Imperata cylindrica, Leersia hexandra, Saccharum narenga, Selerostachya fusca,* and species of *Hymenachne* and *Saccharum* . With the

gradual drying up of the habitat *Phragmites karka* is replaced by *Imperata, Saccharum* and *Sclerostachya.* According to Bor (1960) over- grazing in moist climate, like that of the Assam, reduces the tall grasses to the depauperate tufts of *Chrysopogon aciculatus* and *Imperata cylindrica* .

SUB TROPICAL TYPE 'B'

Dominance of Themeda-Arundinella : This type also comes under the sub tropical type (Whyte, 1968). This occupies parts of Arunachal Pradesh, Assam, Manipur and Meghalaya up to 1050 m. Dominant perennial species are *Arundinella bengalensis, A. nepalensis, Schizostachyum latifolium, Chimonobambusa callosa, Chrysopogon gryllus, Cymbopogon jwarancusa, Cynodon dactylon, Dendrocalamus hookeri, Dichanthium glabrum, D. pertusum, Dimeria fuscescens, Eragrostiella leioptera, Eulaliopsis binata, Heteropogon contortus, Ischaemum barbatum, Saccharum spontaneum, Setaria palmifolia* and *Themeda caudata.* Higher up, *Phyllostachys assamica* and *Dendrocalamus sikkimensis* are common.

Grazing lands in N.E. India (Varshney, 1972)

Name of state	in thousand hectares
Assam Meghalaya Mizoram	233.9
Tripura	53.1
Nagaland Manipur Arunachal Pradesh	Figure not available

The grasslands of Meghalaya, mainly covering the Shillong plateau, have been worked out in detail and are discussed. Bor (1942)stated that larger portion of this plateau is occupied by fields and grasslands and it is almost, if not entirely divoid of trees. Although the grassland is not a climatic climax there is no doubt that these communities are very stable. The grasslands are found in the forest climate if, therefore, the vegetation demanded is not forthcoming then the vegetation must be subjected to some other factors apart from the climate. One factor is fire accompanied or not by another biotic factor the grazing. Here the "sere" is stopped at a point which is not a climax, by some factor which prevents the climate from exercising full control. The grassland is in perfect harmony with the controlling factors, the climatic and biotic, and are therefore stable as long as these factors are operative, Whyte (1957) remarks that the large tracts around Cherrapunji exhibit a distinct major type within the tropical wet ever-green forest. Owing to excessive felling the hills are now covered with the grasses and are more or less under a system of heavy grazing and annual fire. Similar situation is observed in Nongpoh and Nowgong where green forests have been cleared. This is dominated by *Arundinalla* spp. This is fairly well represented at high altitude.

Barapani downs are covered with a luxuriant growth of tall grasses belonging to the tribe Andropogoneae such as *Andropogon ascinodis, Coelorhachis striata, Eulalia fastigiata, E. quadrinervis, Imperata cylindrica, Ophiuros megaphyllus, Phacelurus zea, Rottboellia cochinchinensis, Saccharum arundinaceum, S. longisetosum, S. fallax, S. narenga, Sorghum nitidum, Themeda intermedia, T. triandra* and *T. villosa.* A combination of burning and grazing destroys this completely and the species are replaced by a short turf consisting of *Chrysopogon aciculatus* and *Imperata cylindrica* associated with *Apocopis paleacea, Eleusine indica, Eragrostis atrovirens, E. nigra* and *E. unioloides* . If grazing is stopped, *Imperata cylindrica* becomes dominant.

The grassy rolling downs about Shillong peak and on the flats in the neighborhood of Cherrapunji are covered by a very different assemblage of species. The genera found in such places are for the most part temperate but a number of Andropogoneae occupy special habitats. These include *Pogonatherum*

rufo-barbatum on rocks and along streams : *Dimeria fuscescens, Ischaemum hubbardii, Jansenella griffithiana* in marshy places; *Arthraxon lancifolius, Dimeria ornithopoda* on steep banks *Saccharum rufipilum* along nallahas; *Eulalia speciosa* vars. *speciosa* and *velutina, E. pallens* on edges of cultivated fields etc. where they are protected from grazing. Whyte (1957) has reported *Chrysopogon fulvus* also as a common grass, however, this species is not seen by the author either in the field or in any herbarium, probably he referred to *C. gryllus* which is a very common species in this area. On the wind swept downs and flats *Agrostis griffithiana, Calamagrostis abnormis, Brachypodium sylvaticum, Eragrostis nigra, Festuca leptopogon, F. rubra* var. *clarkei, Garnotia acutigluma, G. tenella, Helictotrichon asperum, Microchloa kunthii, Poa annua,* and *Sporobolus piliferus* are to be found. Where soil cover is thin, *Eragrostiella leioptera* and *Tripogon bromoides* make their appearance. Other species found are *Alloteropsis semialata, Hierochloe khasiana, Sacciolepsis indica, S. myosuroides, Setaria pumila* and *Sphaerocaryum malaccense.*

Some other species common in this state particularly in and around Shillong are *Arundo donax, Chrysopogaon gryllus, Cymbopogon khasianus, Miscanthus nepalensis, Neyraudia reynaudiana, Phragmites karka, Saccharum procerum, S. spontaneum* and *Setaria palmifolia.* Among the herbaceous grasses *Brachypodium svlvaticum, Cynodon dactylon, Festuca leptopogon* and *Helictotrichon asperum* are the common grasses in Polo Ground area. *Axonpus compressus, Cynodon dactylon* and *Poa annua* are common turf grasses often associated with *Apocopis paleacea, Bromus catharticus, Chrysopogon aciculatus, Dichanthum* spp., *Paspalum* spp., *Setaria pumila,* etc.

Pennisetum clandestinum with long creeping stolons and concealed spikelets is also fairly common.

Phalaris arundinacea var. *picta* with green and white or pinkish striped leaves is commonly seen in the gardens and houses in Shillong for its ornamental foliage, the variety is well established and does not revert to its uniformly green leaves form as reported by Bor, (1940). *Briza maxima* with its showy pendulous spikelets has also been gathered once from a private bunglow. Apparently the grass failed to survive and was not noticed since 1960. *Phalaris arundinacea* and *Bromus catharticus* which were collected by Bor about 30 years ago as escapes have well established in some nallahs in Polo Ground and scattered patches of the latter can be seen practically every where in Shillong.

PHYTOGEOGRAPHICAL AFFINITIES OF NORTH-EASTERN REGION

Clarke (1898) analysing the distribution of Cyperaceae considered the north-eastern India (former Assam) and eastern Himalayas as a distinct sub area. Hooker (1906) in his botanical divisions of India included major parts of the north-eastern India along with the Gangetic plains, treating Eastern Himalayas as a distinct area and considered hilly areas of this region including Shillong Plateau (Meghalaya), Patkai, Naga and Manipur hills as botanically akin to Burma (Myanmar). Champion (1936), Chatterji (1940, 1962) and Legris (1963) have also classified the vegetation of India as a whole including this region, into a number of types and sub-types. Rowntree (1953) also has outlined the vegetation, mainly the forest types found in Assam valley.

In support to Hooker (l.c.) it is found that some grasses such as *Bambusa tulda, B. polymorpha* (also found in W. Bengal), *Eulalia manipurensis, Germainia khasiana, Dinochloa maclellandii* (also found in W. Bengal), *Spodiopogon lacei, Themeda caudata, T. intermedia, T. subsericans* are found in this region. Chatterji (1962) following Clarke *(l.c.)* treats N.E.India as a distinct sub-area because of its distinctive flora. Our study of distribution of the grasses of this region also support this view as a number of

species are confined to this region, some of these are; *Arundinaria hirsuta, A. maling, A. mannii. A. rolloana, Bambusa cacharensis, B. mastersii. B. pallida, Chimonobambusa callosa, C. griffithiana*, C. hookeriana *, C. intermedia, C. polystachya, Coelorhachis striata* var. *pubescens, Cymbopogon* jwarancusa var. *assamensis, Dendrocalamus patellaris, D. sahnii, D. sikkimensis *, Dichanthium nagense, D. planipedicellatum, D. pteropechys, Dinochloa indica, Gigantochloa macrostachya, Hymenachne assamica, Hyparrhenia griffithii, Ischaemum hirtum, I. hubbardii, Microstegium borianum, Miscanthus wardii, Panicum incisum, Paspalum longifolium* var. *lorirhachis, Phyllostachys assamica, P. mannii, Pogonatherum rufo-barbatum, Rottoellia goalparensis, Schizostachyum capitatum*, S. dullooa, S. fuchsianum, S. griffithii, S. helferi, S. latifolium *, S. mannii* etc.

Bor (1942) quotes Clarke' s letter to Hooker, in which Clarke was struck by the remarkable differences at comparable altitudes of the flora of Naga hills from that of Khasi hills about 200 km away. The flora of Naga hills has a greater resemblance with the flora of Sikkim Himalayas in particular to that of Darjeeling area which is about 800 km to north-west, separated by the Bramhaputra valley. Among grasses also a few species like *Arthraxon microphyllus* and *Schizachyrium delavayi* are common to Nagaland and Sikkim. Clarke *(l.c.)* had further added from a comparison of the geology and flora of these two hills that the majority of species which comprise both these hills are eastern Himalayan and many species are common to both Khasi hills and Naga hills. Hooker (1854) in Himalayan Journal records that many genera and species appear at 5000' -6000' (1600-2000 m) in Shillong Plateau (present Meghalaya) which are not found in the outer ranges of Sikkim under 10,000' (3500 m). This observation is also supported by species like *Agrostis myriantha, Arundinaria suberecta, Arundinella nepalensis, Brachypodium sylvaticum, Coelorhachis khasiana, Calamagrostis abnormis, Coix lacryma-jobi, Dactyls glomerata, Echinochloa frumentacea, Festuca leptopogon, Helictotrichon asperum, Muhlenbergia huegelii, Saccharum rufipilum .*

It is also interesting to note that several species found around 2000 m in this region, climb up to a greater altitude in Nepal, some of these are *Andropogon munroi* (3900 m), *Arundinella hookerii* (2900 m), *A. nepalensis* (up to 3500 m), *Avena fatua* (3200 m), *Brachypodium pinnatum* (3500m), *Danthonia* spp. (4100 m), *Calamagrostis pulchella, Eulaliopsis binata* (2470 m), *Festuca gigantea* (2700 m), *F. ovina* (3600-4300 m) etc.

Flora of Khasi hills, Meghalaya is also quite interesting. It has an affinity with the flora of Nagaland (Clarke, *l.c.*) as well as that of Manipur (Deb, 1958). Some of the Burmese elements like *Eulalia manipurensis, Germainia khasiana, Spodiopogon lacei, Themeda caudata, T. intermedia, T. subsericans* are found mainly in Khasi hills and Manipur. *Eulalia pallens* has a discontinusus distribution and is found in Khasi hills, India and China. Joseph (1982) working in details on the study of North Khasi hills (Nongpoh area) found some Indo-Malayan, Burmese and Sikkim elements. It has been noted, as pointed by Hooker *(l.c.)* that several Sikkim species are found in Khasi hills at much lower altitude. Similarly a comparison of distribution of grasses common to Nagaland and Khasi hills show that in Nagaland they appear at greater heights some of these species are *Centotheca lappacea, Calamagrostis scabrescens, Phyllostachys mannii, Thamnocalamus prainii, Schizostachyum dullooa* etc.

Among other point of distributional interest is that *Aurndinaria simonii* found in China and Java has recently been gathered from Arunachal Pradesh.

* Species marked in asterisks (*) are also found in W. Bengal, probably they are introduced in that state.

Some of the South Indian species have also been collected from the area of this work : *Apocopis courtallumensis* from Manipur; *Arundinella intricata* and *A. purpurea* from Khasi hills, Meghalaya; *Spinifex littoreus* a grass of southern coastal region, from Tripura.

As may be expected that many species are common to the rest of India as well as Africa. Some of these are : *Arthraxon lancifolius, Axonopus compressus, Brachiaria eruciformis, B. ramosa, Centotheca lappacea, Coix lacryma-jobi, Cymbopogon jwarancusa, C. nardus, Cynodon dactylon, Dichanthium annulatum, D. glabrum, D. pertusum, Digitaria ciliaris, D. longiflora, D. radicosa, Echinochloa colonum, E.pyramidalis, E. stagnina, Eragrostis atrovirens, E. gangetica, Heteropogon contortus, Ischaemum indicum, Leptochloa chinensis, Oplismenus burmannii, O. compositus, Panicum maximum, P. repens, Paspalum conjugatum, P. scrobiculatum, Pennisetum polystachyon, P. purpureum, Poa annua, Polypogon monspeliensis* etc. .

Species common to China are : *Arundinaria simonii, Arundinella setosa, Chloris dolichostachya, Dichanthium assimile, D. glabrum, Eulalia pallens, Eulaliopsis binata, Ischaemum rugosum, Spodiopogon cotulifer* etc.

Dimeria ornithopoda, Oplismenus compositus, Cyrtococcum patens are common with Malaya.

It is also interesting to note that several species found in the neighboring state of W. Bengal has not been collected so far from this region. Similarly more than 50 species found in the neighboring country Myanmar have not been able to migrate to this region.

It is thus seen that the general flora, including grasses, of the north-eastern India maintains its distinct type, it is influenced by the flora of Myanmar, Eastern Himalayas (chiefly Sikkim and Nepal), China, Malaya. Majority of the species, as expected, are common to the rest of India and Africa.

It is equally interesting to note that the 7 states comprising the north-eastern India have distinctive elements in their grass flora and perhaps represent distinct vegetational sub-types, as indicated under the state-wise endemism of the species.

State-wise endemism of species

A few species are confined to more than one state. Some species marked in asterisks (*) appear to have been introduced in W. Bengal.

ARUNACHAL PRADESH

Arthraxon hispidus, Arundinaria maling, Chimonobambusa intermedia, C. callosa, C. griffithiana, C. hookeriana, Dendrocalamus patellaris, D. sahnii, D. sikkimensis*, Gigantochloa macrostachya, Miscanthus wardii, Phyllostachys assamica, P. mannii, Poa wardiana, Schizostachyum capitatum*, S. fuchsianum*, S. latifolium*, S. griffithii, S. seshagiriana, Semiarundinaria pantlingii, Thamnocalamus spathiflorus.*

Thyrsostachys oliveri is stated to have been introduced.

ASSAM

Bambusa cacharensis, B. mastersii, Cymbopogon jwarancusa var. *assamensis, Dinochloa indica, Dendrocalamus patellaris, Gigantochloa macrostachya, Paspalum longiholium* var. *lorirhachis, Phyllostachys assamica, Rottboellia goalparensis, Schizostachyum dullooa, S. pergracile, S. griffithii .*

MANIPUR

Agrostis wardii, Arundimaria clarkei Dichanthium planipedicellatum, Schizostachyumy latifolium, S. pallidum, S. polymorphum, S. mannii .

MEGHALAYA

Agrostis filipes, A. griffithiana, Arundinaria hirsuta, A. mannii, Arundinella

intricata, Chimonobambusa callosa, C. griffithiana, C. hookeriana, C. polystachya, Dendrocalamus sikkimensis, Calamagrostis elatior, Digitaria compacta, D. jubata, Eragrostiella leioptera, Eulalia speciosa var. *velutina, Festuca rubra* var. *clarkei, Ischaemum hirtum, I. hubbardii, Panicum khasianum, Phyllostachys mannii, Pogonatherum rufo-barbatum, Schizostachyum dullooa, S. helferi, S. griffithii, S. latifolium, S. pallidum, S. polymorphum, Thamnocalamus prainii .*

MIZORAM

Sinarundinaria longispiculata.

NAGALAND

Calamaagrostis nagensis, Andropogon munroi, Arundinaria hirsuta, A. rolloana, Dendrocalamus patellaris, D. sikkimensis, Dichanthium nagense, D. pteropechys, Calamagrostis nagarum, Panicum incisum, Schizostachyum dullooa, S. fuchsianum, S. latifolium, S. mannii, S. pergracile, S. polymorphum, Sinobambusa elegans, Thamnocalamus prainii.

In addition to these a few species like *Arthraxon breviaristatus, Coelorhachis striata* var. *pubescens, Hymenachne assamica* and *Isachne clarkei* are confined to this region.

MATERIALS AND METHOD

The present work is based on critical examination of the huge amount of herbarium materials deposited in the Central National Herbarium, Botancial Survey of India, Howrah (CAL); Eastern Circle, Botanical Survey of India, Shillong (ASSAM); Forest Research Institute, Dehra Dun (DD); Botanical Survey of India, Dehra Dun (BSD); Botancial Survey of India, Allahabad (BSA) and North Eastern Hill University, Shillong (NEHU). These include historical collections of Craib, Gallatly, Griffith, Gustav Mann, Jenkins, Masters and Oldham from plains of Assam and Brahmaputra valley. Clarke, Gustav Mann, Hooker & Thomson from Khasi hills; K. Ward from Balipara Frontier Tract; Bor and Haimendorf from various parts of Arunachal Pradesh, Manipur, Nagaland, Khasi hills and Assam.

Collections of Late Rai Bahadur U. N Kanjilal in whose memory the ASSAM herbarium is also called 'Kanjilal Herbarium' and his equally devoted son P. C. Kanjilal alongwith the other forest officers notable among them being A. Das, G.K.Deka, Dina Nath and S.K.Sharma etc. were also examined.

Most of the materials on which Bor' s account of the grasses of Assam (Flora of Assam Vol. V. 1940) was based and some of the materials which formed the basis of the account of the grasses of Manipur (Deb, 1961) and Flora of Tripura (Deb, 1981 & 1983) were also available for study.

With the inception of the Botanical Survey of India, Eastern Circle at Shillong the Old Forest Department's herbarium was transferred to it. Since then various officers of the Botancial survey of India have gathered a huge amount of collections, including the grasses, from practically all the parts of former Assam e.g. Deb from Tripura and Mizoram, Joseph from Kameng, A.S. Rao from Kameng and Kamrup, M.K.V. Rao from Garo Hills, Bhowmick from Western parts of Khasi Hills etc. In addition to these, flora of Jowai has been worked out by Balakrishanan (1981, 1983) and that of Nongpoh and adjoining areas by Joseph (1982). All these recent collections of Botanical Survey of India including those publised by Deb & Datta (1971, 1974) on Tirap, Panigrahi and Joseph (1966) on Tirap, Rao & Rabha (1966) on South Kamrup and those of the author' s from various parts of Arunachal Pradesh, Assam, Manipur, Meghalaya and Mizoram either singly or jointly with S.K. Jain were also critically examined.

Apart from these a good number of specimens without any specific locality or collector' s name or even any indication of the area of collection or any data were also examined. Some collections of the workers outside the Botanical Survey of India, such as

staff of Forest Research Institute (Dehra Dun), students of Chandigarh University, Gauhati University, and occasionally from Forest Departments of Assam and Meghalaya were also available for the study.

The grass materials in herbaria mentioned, include indentifications or reidentification by renowned workers on Indian flora like C.B. Clarke, N.L. Bor, M.B. Raizada, K.C. Sahni, S.K. Jain and subsequent workers of the Botanical Survey of India and Forest Research Institute engaged in the studies on this area.

In majority of the cases the earlier identification, on scrutiny, were found to be correct but in several cases changes were essential. In a few cases identities were confirmed at Kew also.

An effort has been made to include specimens in this account only after a critical study. But several specimens such as from those included in the 'Flora of Lushai' (Fischer. 1938), 'Grasses of Burma, Ceylon, India and Pakistan' (Bor 1960), 'Monocotyledonous plants of Manipur' (Deb 1961) were not available for examination. Those species whose report from this region have been found to be reliable have been included on the authority of such published works.

During the progress of work types of approximately 50 species were located at Central National Herbarium (CAL), Forest Research Institute (DD) and Eastern Circle (ASSAM). In addition to these several sheets quoted by Bor (1960) were also available in these herbaria.

The classification followed here is basically that of Bor (1960) slightly modified after Clayton (1971, 1974) and Hutchinson & Dalziel (1972). In this treatment genera have been dealt directly under their relevant tribes without going into the sub-family level of Bor (1960.) Dichotomous keys have been provided. More emphasis has been laid on habit, general facies of the grasses and other such characters which can be conveniently checked with the help of an ordinary hand lens.

Salient characters of the family, tribes, genera and species or sub varietal ranks have been provided in the descriptions.

For each species, in addition to, the currently accepted name, its reference in the 'Flora of British India vol.7' (Hooker, 1896-1897), 'Flora of Lushai hills' (Fischer, 1938), 'Flora of Assam. vol.V.' (Bor, 1940), 'Grasses of Burma, Ceylon, India and Pakistan' (Bor, 1960), and 'Flowering plants of eastern India. vol.I. Monocotyledons' (Mitra, 1958) and basionym also have been given. This is followed by diagnostic characters, distribution within the area of the work, in India and the world is given. A number of genera according to Clayton & Renvoize, 1986 is also provided. Period of flowering and fruiting, ecological notes and economic importance, critical notes, wherever necessary have also been provided.

ABBREVIATIONS USED

Ass.	Assamese
ASSAM	Herbarium of the Botanical Survey of India, Eastern Circle, Shillong.
apud	in the work of
auctt. non	not of (the particular author).
Beng.	Bengalese
Bor, 1940	Flora of Assam, Vol. V. Gramineae. Calcutta.
Bor, 1960	Grasses of Burma, Ceylon, India and Pakistan. London. (reprinted edition Otto Koeltz, Germany 1973.)

BSD	Herbarium of the Botanical Survey of India, Northern Circle, Dehra Dun.
ca	circa = about
CAL	Central National Herbarium, Howrah.
cm	centimeter
comb. nov.	combination nova = new combination
DD	Herbarium of Forest Research Institute, Dehra Dun.
Descr.	descriptio = description.
emend.	emendevit = emended
Eng.	English
ex	published by
f.	(after an author' s name) the son
Fischer, 1938	Flora of Lushai hills. Records of Botanical Survey of India 2 (12). 1938.
fls. & frt.	flowering and fruiting
Hooker	J. D. Hooker
Hooker, 1896-1897	Flora of British India, Vol. 7.
ibid.	ibidem = in the same place.
ICBN	International Code of Botanical Nomenclature.
l.c.	loco citato = at the place cited (location cited).
Kh.	Khasi (language).
m	meter (100 cm)
Mitra, 1958	Flowering plants of Eastern India, Vol. I. Monocotyledons. Calcutta.
N.E.India	North-eastern India (former Assam).
NEHU	Herbarium of North Eastern Hill University, Shillong
Nep.	Nepalese (language)
nomen genericum conservandum	generic name conserved owing to long usage, although an earlier valid name was available.
nomen. illegitimum	name not valid
nomen.; nomen nud.	new name without description.
nomen supperflu.	superfluous name
pro parte	in part
syn. nov.	synonym nova = this name first used here as a synonym
t.	tabula = plate
T	type specimen

OTHER RELATED BOOKS

A Manual of Ethnobotany *Jain S.K.* (Ed.) 2nd Ed.	1995	81–7233–104–9
Flora of Savantwadi *Almeida, S.M.*	1990	81–85046–87–5
Orchids in India *Maheshari J.K.*	1995	81–7233-114-2
The Flora of Jabalpur. *Oommachan, M.*	1996	81–7233–110–X
Flora of Upper lidder valleys of Kashmir Himalaya, Vol–1 *Sharma, B.M. and P.S. Jamwal*	1988	81–85046–63–8
Grasses and Bamboos of India, Vol. 1–3 *Moulik, Sunanda*	1996	81-7233-073-1
Grasses of Marathwada *Patunkar, B.W.*	1980	81-85046-05-0
Weed Flora of Kashmir Valey *Kaul, M.K.*	1986	81-85046-28-X
Systematic studies in Polygonaceae of Kashmir Himalaya *A.H. Munshi and G.N. Javeid*	1986	81-85046-95-X
Taxonomic studies on Indian species of genus Ixora L. (Rubiaceae) *T. Husain and S.R. Patel*	1989	2050-9768
Ferns and Fern-Allies of Meghalaya *Baishya, A.K. and R.R. Rao*	1981	81-85046-07-7
Tropical Grasses *F.A.O.*	1992	81-7233-033-2

SCIENTIFIC PUBLISHERS

5–A, New Pali Road, P.O. Box No. 91,
Jodhpur– 342 001 (India)