

# HEPATICAE OF KHASI AND JAINTIA HILLS: EASTERN HIMALAYAS

Ajit Pratap Singh  
Virendra Nath



## ABOUT THE BOOK

The book presents a comprehensive floristic account of "Hepaticae of Khasi and Jaintia Hills: Eastern Himalayas", one of the hot spots of the country. A consolidated critical account of various taxa and families of this region has been provided for the first time.

This book consists of original research work dealing with diverse aspects like morpho-taxonomy, diversity, distribution, habitat, ecology, altitudinal range and discussion of 247 species of hepatics falling under 59 genera and 23 families supported by 86 line drawing illustration plates, 48 coloured photographs and 21 distributional maps. The book includes discovery of 10 new species and addition of 22 species to Indian bryoflora belonging to 12 genera.

Additionally the book is also supplemented with the precise notes on application of hepatics, rare, endangered and threatened (RET) taxa, conservation, bryophytes as pollution indicator, mineral indicator, as medicines, active chemical compounds, antimicrobial activities, ethno-bryology and other miscellaneous usage of bryophytes.

It will provide one hand information which will be of immense utility not only to botanists in general but also to environmental biologists, foresters, landscapists, naturalists, amateurs and other specialists concerned with plant sciences in any way. This publication will be an immensely valuable reference book to postgraduate students, researchers and to all those interested in bryophytes and field biology.

## ABOUT THE AUTHORS



**Dr. Ajit Pratap Singh**, after passing M.Sc. from Dr. R.M.L. Avadh University, Faizabad joined the Bryology Laboratory, National Botanical Research Institute, Lucknow in the year 1998 as JRF and later awarded SRF (CSIR), New Delhi. During these years he actively worked on Assessment of Liverworts in Khasi, Garo, Jaintia Hills: Eastern Himalayas and conservation strategies of rare, endangered and threatened liverworts. Dr. Singh was decorated with Ph.D. degree in the year 2003 under the able guidance of Dr. Virendra Nath, Deputy Director and Head, Bryology Laboratory, National Botanical Research Institute, Lucknow. Dr. Singh is keenly involved in the biodiversity, distribution, habitat, ecology, morphology, taxonomy, phylogeny and conservation studies of bryophytes. He has extensively explored the bryophytes in Eastern Himalayas, Western Himalayas, Central India and have discovered more than ten new bryophytic taxa for science. Dr. Singh is Joint Secretary of Association for Plant Taxonomy (APT), member of various scientific societies and published more than 17 research papers in the Journals of national and international repute. Presently he is pursuing his Research Associateship (CSIR) on Bryodiversity (Hepaticae) of Sikkim Himalayas and Assessment of Rare, Endangered and Threatened taxa at the Department of Botany, Lucknow University, Lucknow.



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Dr. Nath have about 125 research papers to his credit, published in National and International Journals on various aspects, viz., morpho-taxonomy, diversity, distribution, ethno-botany, chemistry, ecology, genomic and antimicrobial activity of some selected Indian Bryophytic taxa. Besides, he has also published several review articles, popular papers, chapter in books and edited a book entitled "Perspectives in Indian Bryology".

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Dr. Nath has supervised several projects supported by DBT, DST, MoEF, CSIR, UPCST etc. and guided several students for Ph.D. degree, as well as also trained post graduate students on bryophyte studies.

# HEPATICAE OF KHASI AND JAINTIA HILLS: EASTERN HIMALAYAS



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Front Cover Photo :

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1. *Herbertus sikkimensis* (Steph.) Nichol.
2. *Plagiochasma intermedium* Ldbg. et G.
3. *Scapania okamuraana* Steph. ex Amak. et Hatt.
4. *Pallavicinia indica* Schiffn.
5. *Dicranolejeunea gilva* Steph.
6. *Frullania nepalensis* (Spreng.) Lehm. et Lindenb.
7. *Asterella blumeana* (Nees) Kachroo
8. *Chandonanthus hirtellus* (Web.) Mitt.
9. *Heteroscyphus bescherellei* (Steph.) Hatt.

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1. *Ptychanthus striatus* (Lehm et Lindenb) Nees

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*Dedicated*  
*to our*  
*beloved Parents*

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## FOREWORD

Bryophytes have long lagged behind vascular plants in terms of numbers of workers and as a consequence the advancement of bryological knowledge has often been slow in comparison. Because of their small size and delicate structure, magnification is required if bryophytes are to reveal their secrets to the researcher. Thus, the advent of commercially available microscopes was necessary before most people could study mosses and liverworts. Even with this advancement, though, bryophytes have never been popular. It is similar to why birds and mammals (the charismatic macrofauna) will always have more fans than far more diverse invertebrate groups. Nevertheless, bryophytes have a special place in the history of botany. For example, sex chromosomes in plants were first discovered in bryophytes, and only later found in flowering plants.

Currently, a bryophyte (*Physcomitrella patens*) is one of the model organisms in genomic studies, having an even faster life-cycle than the over-used *Arabidopsis*, and is particularly advantageous because of the dominant gametophyte generation. Bryophytes and other cryptogams have been found to be far more accurate bioindicators than vascular plants because of their sensitivity to the environment. However, if we don't know have the correct identity of the moss or liverwort at hand, then any ecological, physiological or genomic study is inherently flawed. Despite significant advances in some frontiers of bryology, our knowledge of the world's bryoflora continues to be limited. Unlike vascular plants, in which biodiversity seems to be highest in lowland tropical forests, bryophytes reach the peak of their diversity at higher elevations, in both temperate and tropical zones, where temperatures and humidity fluctuate more, both daily and seasonally, and thus provide a greater variety of microhabitats that bryophytes can exploit. Although this diversity can be exciting for a professional bryologist, it is often confusing for the beginner or amateur. It is this level of frustration that explains why more people never become interested in this fascinating and diverse group of plants. Traditionally, many species of bryophytes were thought to be widespread if not actually cosmopolitan.

However, recent research, based both on DNA sequencing of selected loci from throughout different genomic compartments and on more sophisticated morphological study, has found that many formerly presumed widespread bryophyte species are actually species complexes. Thus, as our understanding of bryophyte biology progresses, our estimates of the numbers of bryophytes continues to increase. The majority of bryophytes consequently remain inaccessible for all but those at major research institutions with modern laboratory facilities, good libraries and herbarium reference collections. Although with far fewer species than mosses, liverworts have been particularly afflicted by this problem. For large areas outside of Europe and North America there are very few if any identification guides for any group of organisms, but especially for liverworts.

This is particularly unfortunate for the Himalayan region because it is one of the hotspots for bryophyte diversity, and a area from which species of bryophytes new to science continue to be discovered on a regular basis. India has a long and distinguished history of bryology, but for the most part this work has been confined to mosses. The present volume certainly helps to address this disparity.

This is the first significant attempt at floristic studies of Indian Hepaticae since Kashyap's pioneering Liverworts of the Western Himalayas and the Panjab Plain (1929–1932). It is a nice complement to Kashyap's early work because it focuses on the Eastern Himalayas. The present contribution by Drs. Singh and Nath is based on Singh's Ph.D. thesis from Dr. Ram Manohar Lohia Avadh University in conjunction with the National Botanical Research Institute. Dr. Nath, one of the most prominent bryologists in India, mentored this study and now, in its reworked form, he rightfully takes his place as a co-author.

The book in the reader's hands presents taxonomic studies, diversity, distribution, habitat, ecology and discussions on phylogenetic inter-relationships of almost 250 species of liverworts in over 20 families. The plants are elegantly illustrated by original line drawings, as well as by 48 color photographs. Additionally many of the species are mapped. These data are used as the basis for discussion on such interesting topics as hepatic rareness and conservation, the use of hepatics as bioindicators and the emerging field of ethnobryology. The many new species described in this work, originally included in the thesis, are finally validly published here. This allows these names to now be used in more broadly circumscribed works, such as monographs and other regional hepatic floras. Those without access to the original thesis will now find many new regional records. One hopes that this work is but the first in a series of Indian hepaticological floras. Certainly Drs. Singh and Nath have set the bar very high for subsequent researchers to meet.

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## PREFACE

Amongst twelve megabiodiversity center of the world, India exhibit two hot spots namely Eastern Himalayas and Western Ghats. These two hot spots and speciation centers are less visited by cryptogamic botanists particularly bryologists. In Eastern Himalayas as such there is no floristic account on bryophytes and only scattered and fragmentary informations are available on these tiny group of plants. The variable and diverse climates, phytogeography, habitat and rainfall has compelled the Cherrapunji and Mawsynram of Meghalaya: Eastern Himalayas to be the rainiest place of the world. These ecological factors favouring extreme speciation and luxuriant growth have enriched bryophytes diversity in Meghalaya: Eastern Himalayas. The maximum new species and new records are still to be explored from these regions. Inspired by the scope of flora, new species and new records of bryophytes, present floristic work have been undertaken to access the bryodiversity of Meghalaya. The work described in present contribution "Hepaticae of Khasi and Jaintia Hill: Eastern Himalayas" was carried out at National Botanical Research Institute (CSIR), Lucknow, India. The work is extensively based on the bryophytes collected from Khasi and Jaintia Hills: Meghalaya by authors themselves and earlier workers in successive exploration trip during different seasons as well as on loaned specimens from various herbaria and exsiccate. The investigation aim is to provide a comprehensive, up to date floristic account and to resolve the taxonomic problems existing in Indian bryophytic taxa at family, genus and species level. An effort has, therefore, been made to provide the considerable information on the taxa of Khasi and Jaintia Hills which has never received adequate attention.

About 2000 collection samples have been critically examined for morphotaxonomic features and are put forth according to their taxonomic rank in present contribution. The basic knowledge about the various genera and species investigated in the present work has been developed through critical observations of Holotypes and other original specimens which were obtained on loan from various foreign herbaria viz. New York Botanic Garden (NY); The Hattori Botanical Laboratory, Japan (NICH); Field Museum of Natural History, Chicago USA (F) and Hepatic Herbarium, Lucknow University, Lucknow (LWU). Besides, specimens from Exsiccate Hepaticae Japonicae editit S. Hattori has also been examined.

The description and discussion are based on the taxonomic concepts which have been evolved through comprehensive studies of the living and herbarium specimens with special attention to the critical comparative characters, including the range of variations as well as authenticity. The description of families, genera and species has been given. Relevant keys to segregate the genera and species have also been provided. The taxonomic treatment includes full citation(s), relevant synonym(s) followed by taxonomic description (supplemented with latin diagnosis in case of new species), distribution and ecology, references to specimens examined, discussion, diversities and affinities with related species. The keys of only those taxa have been provided which were under study. Those taxa which were earlier described by other bryologists before this work have not been included in the keys but their brief description with citation etc have been provided in continuation of the taxa investigated.

The present work includes taxonomic observation, diversity, distribution, habitat, ecology and discussion of 247 species, 59 genera belonging to 23 families supported by 86 linedrawing illustrations, 48 photographs and 21 maps. It has been observed that about 166 taxa have been added in addition to the earlier known 81 taxa in the Khasi and Jaintia Hills. The study has also revealed that 12 genera viz. *Plagiochila* (Dum.) Dum., *Plectocolea* Mitt., *Frullania* Raddi, *Lopholejeunea* (Spruce) Schiffn., *Lejeunea* Libert., *Cheilolejeunea* (Spruce) Schiffn., *Lophocolea* (Dum.) Dum., *Jungermannia* L., *Calypogeia* Raddi, *Drepanolejeunea* (Spruce) Schiffn., *Trocholejeunea* Schiffn., and *Sphenolobus* (Lindb.) Steph., with 22 species: *Plagiochila trabeculata* Steph., *P. satoi* fo. *japonomontana* (Hatt.) Inoue, *P. pseudoventricosa* Inoue, *P. magna* Inoue; *Jungermannia* (*Plectocolea*) *shinii* Amak., *J. (Plectocolea) flavi-albicans* Amak., *J. (Plectocolea) truncata* var. *setulosa* (Herz.) Amak; *Lopholejeunea recurvata* Mizut., *L. nongstoinii* sp. nov., *Lejeunea japonica* Mitt., *Cheilolejeunea ontakensis* (Steph.) Hatt., *Lophocolea fragrans* Moris et De Not., *Jungermannia erectii* sp. nov., *J. amakawana* sp. nov., *J. mairangii* sp. nov., *Calypogeia khasiana* sp.

nov., *Drepanolejeunea mawmiana* sp. nov., *D. longifolia* sp. nov., *Trocholejeunea meghalayensis* sp. nov., *Sphenolobus langkyrdumii* sp. nov., *Frullania udarii* sp. nov., and *Frullania rotundistipula* Steph., have been reported for the first time from India. However, out of 22 taxa 10 species are newly instituted which are significant contribution to the science.

Besides, the investigation have also revealed that 12 taxa viz. *Plagiochila trabeculata*, *P. satoi* fo. *japonomontana*, *P. pseudoventricosa*, *P. magna*, *Plectocolea shini*, *P. flavi-albicans*, *P. truncata* var. *setulosa*, *Frullania rotundistipula*, *Lopholejeunea recurvata*, *Lejeunea japonica*, *Cheilolejeunea ontakensis* and *Lophocolea fragrans* of this region have been reported for the first time which are new addition to Indian Bryoflora. The study has also shown that Lejeuneaceae family is dominantly growing and representing higher number of taxa i.e. 52 species, next to this is Jungermanniaceae with 32 species. The smallest families in this area are Fossombroniaceae, Targioniaceae, Pelliacae. The former two families are represented by only 1 taxon i.e. *Fossombronia cristula* Aust. and *Targionia hypophylla* L., respectively. However, the latter family is represented by two taxon: *Pellia neesiana* (Gott.) Limpr., and *P. epiphylla* (L.) Corda.

The most dominant genus common in occurrence in the area is *Frullania* with 31 species followed by *Plagiochila* with 21 species. Moreover, the other genera common in occurrence are *Ptychanthus*, *Lejeunea*, *Cheilolejeunea*, *Lopholejeunea*, *Jungermannia*, *Calypogeia*, *Chiloscyphus* in leafy and *Marchantia*, *Riccardia* and *Dumortiera* in thalloid liverworts. Furthermore, investigations have also shown that *Ptychanthus striatus*, *Heteroscyphus bescherellei*, *Calypogeia fissus*, *Lejeunea punctiformis* and *L. flava* species are common in occurrence, whereas *Targionia hypophylla*, *Odontoschisma denudatum*, *Notoscyphus paroicus*, *N. pandei*, *Sphenolobus langkyrdumii*, *Fossombronia cristula*, *Leptolejeunea foliicola*, *Frullamoides tristis*, *Drepanolejeunea longifolia* and *D. erecta* are very rare.

As per the altitudinal distribution is concerned the liverworts growth is more luxuriant between 4500-6000 ft. *Frullania muscicola*, *Trichocolea tenera*, *Radula complanata*, *Ptychanthus striatus* and *Lejeunea cavifolia* reaches to maximum height of 5600-6000 ft in distribution, whereas *Fossombronia cristula* and *Pallavicinia* spp. are found to occur at the lowest height 1700-2550 ft.

Investigations have also revealed that in Khasi and Jaintia Hills: Meghalaya the hepatics are dominated in Mawphlong forest, Cherrapunji, Elephant falls, Dawki, Langkyrdum in East Khasi Hills; Nongstoin, Mawkyrwat in West Khasi Hills and Jowai in Jaintia Hills regions. These localities seems to be hot spots for bryophytic wealth in these hills (Meghalaya).

This comprehensive work includes a brief introductory chapters which also includes review of literatures followed by materials and methods, taxonomic observations, discussion and relevant references.

Thus, present publication has wide scope of researches on various aspects of bryophytes in near future and will help as a guide book for teachers, researchers, foresters and students world wide.

November, 2007

**Ajit Pratap Singh**  
**Virendra Nath**

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## INTRODUCTION

Hepaticae (Liverworts) is a very diverse group of plants containing several distantly related and variable representations in evolutionary aspect. The preference of existence of this group also varies according to geographical points of origin, therefore the variations become unavoidable assets in their current regions of luxuriant abundance and diversity. Although, liverworts occur almost throughout the world with majority of taxa distributed at high altitude in temperate region with cool and consistently moist climatic conditions. India is one of the twelve megabiodiversity centre of the world having Eastern Himalayas and Western Ghats as recognized hot spots amongst eighteen hot spots on globe. The Eastern Himalayas region of India has considerably rich botanical diversity (Prance, 1995). Floristic richness and diversity of India, particularly Eastern Himalayas is well remarked in an esteemed publication of Hooker (1904) where he stated "The flora of India is more varied than that of any other country of equal area in the Eastern Hemisphere, if not in the globe". This diversity and richness of the floral wealth of Eastern Himalayas region is due to the variable climatic conditions, habitat, geography and altitudinal variations. Meghalaya, the North Eastern region of India with diverse floral wealth and culture was created as an autonomous state and separated from the Assam State on 2<sup>nd</sup> April 1970, which full fledged came into existence on 21<sup>st</sup> January 1972, is probably one of the richest region of the country from floristic point of view. The most of the parts of the state are underexplored particularly from bryofloristic view point. Meghalaya literally meaning the abode of the clouds is essentially a hill state of diverse climate, topography, with rainiest place of the world i.e. Cherrapunji and Mawsynram has torrential annual rain fall 2992.6 millimeter. Meghalaya comprises of an area of about 22,429 sq km lying within 24°58'-26°8' N and 89°47'-92°50' E bordered in South and West by Bangladesh, east and north by Assam.

The Khasi and Jaintia hills which forms the central and eastern part of Meghalaya is an imposing plateau with rolling grassland hills and river valley (Bor, 1936; Balakrishnan, 1981). These two hills ranges from 600-6400 ft altitude above sea level, has a large central plateau, a continuation of the Shillong plateau of Khasi hills appearing from western border of the district near Mawryngkheng to Raliang in the east, Nartland-Mynso in the north and ending to the Jarain, Khleihriat in the south. The Khasi hills is divided into two regions, the first one East Khasi hills head quarter is Shillong with an area of about 2,748 sq km bordered in the east by Jaintia hills, in south by Bangladesh in west by Mairang and Mawkyrwat subdivision of West Khasi hills and in North near Umiam Lake by Ribhoi district. The second region West Khasi hills having its headquarter at Nongstoin with 5,247 sq km area, lying each within 25°7.5'-25°51' N and 90°45'-92°11' E is bordered in east by Jaintia hills, in south Bangladesh, in west by Garo hills and in north by Assam. However, Jaintia Hill's headquarter Jowai with 3,819 sq km area lying within 24°58'-25°45' N and 92°-92°50' E is bordered in the east by Cachar hills, in north by Mikir hills in west by Khasi hills and in south its descent is rather abrupt into the plains of Bangladesh. The geology and topography of Khasi and Jaintia hills suits well with favourable environmental conditions for luxuriant growth and development of forest flora and agricultural crops. This region is predominantly composed of metamorphic rocks consisting of schist, granites, argillites, quartz and perodites. The soils are mainly laterite with an assortment of brown and red soil on high land and black to yellow in the valley. The lime stones are very common component of soils. Loose soil is very scanty in open areas, however, the sandy soils are common in low land and rainfull regions i.e. Cherrapunji in East Khasi hills; Mawkyrwat, Mairang in West Khasi hills and Khleihriat in Jaintia hills. Climate of both hills are very mild for suitability of the invasion and development of floristic wealth. The rainfall is firmly distributed throughout all the months. The summer monsoon sets in during June-July which is accompanied by squally wind. The clouds are precipitated by these squally winds resulting heavy rainfall. This monsoon remains continue upto September contributing about 75% of the total annual rainfall. In mid monsoon months of July-August the heaviest rainfall occurs in between Cherrapunji and Mawsynram which is not unusual as much as 1633 millimeter. The autumn progression leads to the replacement of south west monsoon by north east monsoon which continues till January. A strong southerly wind blows across the plateau; at peaks the inter monsoon period is hottest and driest of low wind velocity in February and March (Balakrishnan, 1981).

All together, abiotic factors favour well the luxuriant growth and richness or excuberance of plant species particularly liverworts, but unfortunately the knowledge about the richness of the liverworts flora, its diversity and distribution in India is rather scanty. The collection and the study of Bryophytes can be traced back to the year 1802-1803 when Dr. Francis Buchanan Hamilton as superintendent, East India Company Botanic Garden Shibpur made collections mainly from Kathmandu Valley of Nepal on this collection “Musci Nepalensis” of W.J. Hooker (1808) is based. In India the publication of Hooker (1818; 1820) and of Lindenberg and Lehman (1832) on mosses and liverworts appear to be the pioneer research. Succeeding Dr. Hamilton, next superintendent of East India Company Botanical Garden, Dr. Nathaniel Wallich explored Himalayas and all of his collections including 114 moss species have been enumerated in “Wallich Catalogue” (1828-1832) with 55 species by Royle (1839) from Western Himalayas is reproduced by Royle (*l.c.*).

Subsequently, Griffith (1842, 1849, 1849a) described 101 moss species from Upper Assam, Khasia, Sikkim, Bhutan, Burma, Central Indiana and Malacca; Montagne (1842), Schmid (1918) variously made comprehensive study on mosses from Nilgiri hills. The study on liverworts collected by Wallich and Wight from Himalaya region was made by Gottsche *et al.* (1844) and Gottsche (1847). Goebel (1910) described the evolutionary principle of *Monoselenium tenerum*. In the mid of 19<sup>th</sup> century Mitten (1859; 1860; 1861) carried out study on the bryophyte collections made by various workers particularly from Assam and Khasia hills by Griffith, Thomson and Hooker and described comprehensive account on Indian mosses and liverworts. Muller (1853-1854, 1869-1870, 1871, 1878); Mitten (1873); Brotherus (1898, 1899, 1909-1910, 1924-1925, 1928) made comprehensive study on mosses from Ceylon, Western Himalayas and South India. Schiffner (1899) described 35 liverwort species amongst the collections made by Durel from Bhutan. Later on in the beginning of twentieth century a comprehensive work by Stephani (1900, 1906, 1906-1909, 1909-1912, 1912-1917, 1917-1924) on liverworts of world appeared in six volumes mainly on the plants, collected from Sikkim, India Orientalis, Burma, Khasi Hills, Himalayas, Ceylon, Nepal, Madura. Moreover, K. Muller (1901) provided a comprehensive account on *Scapania* from India Orientalis and Gola (1914) on hepatics of Kashmir. Earlier, study were made by Britishers and foreign botanist particularly on bryophytes.

The emphasis on Indian Hepatics by an Indian bryologist was first made by Kashyap (1914) who is now considered as the father of Indian bryology. Kashyap (1914, 1915, 1915a, 1916, 1917, 1928, 1929, 1932, 1932a) made studies on various hepatics of India and is considered to be prime Indian Hepaticologist. Kashyap (1929, 1932, 1932a) provided the first exclusive study on the liverworts of Western Himalaya and Punjab plain in the form of valuable publication, where he described 161 species including four genera and fifty species new to science. Furthermore, no attempt has been made for liverwort flora of any state in India. Descendents of Kashyap like Pande (1924, 1932, 1933, 1936, 1952, 1958); Udar (1970, 1973) made continuity on cytological, physiological and morphological studies of byrophytes. The emphasis made by Pande (1958) on aspect of preparation of monographic account of various genera growing in India was given adequate attention and such studies became apparent through the encouraging achievements obtained from the taxonomic studies of the genus *Riccia* (Udar, 1956, 1957, 1957a, 1959, 1966; Pande and Udar, 1959). Moreover, the successive monographic studies was led with the study on the Indian representatives of the family Rebouliaceae (Chandra, Ph.D. thesis, 1968); sub order Metzgerineae (Srivastava, Ph.D. thesis, 1969); order Calobryales (Kumar, Ph.D. thesis, 1974); family Frullaniaceae (Nath, Ph.D. thesis, 1977); Cololejeuneoideae (Srivastava, Ph.D. thesis, 1984); Indian Hornworts by Asthana and Srivastava (1991); Indian Lepidoziineae by Sharma and Srivastava (1993); Indian Geocalyceae by Srivastava and Srivastava (2002) etc.

With due consideration on monographic studies of liverworts several contributions has been made on various group of liverworts following the systematics proposed by Evans (1939); Grolle (1972); Schuster (1953, 1966, 1969, 1980, 1983, 1984). Once a very interesting taxon *Takakia ceratophylla* (Mitt.) Grolle was described by Grolle (1963) from Sikkim under liverworts which now has been transferred in musci by Smith and Davison (1993). Udar and Chandra (1961; 1965) made comprehensive account on the genus *Calobryum* and Udar *et al.* (1968) described *C. blumii* Nees from Meghalaya. Subsequently genus *Herbertus* Gray has been studied by Montagne (1942); Stephani (1909, 1922); Herzog (1939). A comprehensive study on genus *Herbertus* Gray in Indian bryoterritory was made by Miller (1965; 1968). Singh and Nath (2006) also described *H. sikkimensis* (Steph.)

Miller, *H. ceylanica* (Steph.) Miller, *H. dicrana* (Tayl.) Miller, *H. fragilis* (Steph.) Miller and *H. mastigophoroides* Miller from Meghalaya. Udar and Singh (1977) described *Trichocolea indica* and *T. tenera* from Eastern Himalayas. Moreover, Hattori and Mizutani (1968) described the Asiatic species of *Pseudolepicolea* from Sikkim Himalayas. The members of the family Lepidoziaceae received adequate attention by Mizutani (1967); Mitten (1860-61); Schiffner (1899); Stephani (1908, 1924); Chopra (1938, 1943); Herzog (1939a); Hattori (1966) and Sharma and Srivastava (1993). Taxa of the family Cephaloziaceae and Cephaloziellaceae in India was emphasized by Pande and Srivastava (1955); Udar and Kumar (1982, 1982a); Udar and D. Kumar (1976); Udar and Nath (1973). Singh *et al.* (2003) described sporophytic details of *Cephalozia pandei* Udar *et* Kumar from Meghalaya. An account of the members of the family Harpanthaceae viz. *Chiloscyphus* and *Lophocolea* were described from Western Himalayas by Kashyap (1932). Recently, Srivastava and Srivastava (2002) provided a comprehensive account of the Indian Geocalyceae.

Another family of the Hepaticae, the Jungermanniaceae in India has been worked out by various bryologists. A series of studies on some Asiatic species of the family Jungermanniaceae has been published by Amakawa (1963). He has given emphasis on the study of Jungermanniaceae of Eastern Himalayas, Sikkim, Darjeeling and West Bengal. He also included in his study *Diplocolea sikkimensis* Amak., *Jungermannia appressifolia* var. *minor*, *Nardia assamica* (Mitt.) Amak. and *Jungermannia lanigera* Mitt. He has also instituted some taxa as new to science from the Indian bryoterritory. Moreover, Amakawa (1967, 1968, 1970, 1972) made subsequent study on *Jungermannia limbatifolia* Amak., *J. heterolimbata* Amak., *J. decolyana*, *J. subrubra* Steph., *J. parvitexta*, *J. appressifolia* Mitt., *J. pseudocyclops* Amak., *J. atrobrunea* Amak., *J. orbiculata* Amak., *J. filamentosa* Amak., *J. comata* Nees, *J. truncata* Nees from Sandakphu, Darjeeling, Sikkim and *J. tetragona* Lindb. from Khasi and Jaintia Hills Meghalaya. Udar and Kumar (1981a, 1983) described *J. rubripunctata* (Mitt.) Amak. from Darjeeling and Sikkim and *J. tetragona* Lindb. from Khasi and Jaintia Hills, Meghalaya. Kitagawa (1965) made study on the genus *Chandonanthus* Mitt. from India. Udar and A. Kumar (1982b) described *Chandonanthus birmensis* Steph., *C. hirtellus* (Web.) Mitt. from Darjeeling (Kurseong) and Elephant falls Shillong, Meghalaya, respectively. However, Udar and Kumar (1981b) described two new species i.e. *Notoscyphus darjeelingensis* Udar *et* Kumar and *N. pandei* Udar *et* Kumar including *N. lutescence* (Lehm.) Mitt. and *N. paroicus* Schiffn. from India.

Hattori (1966, 1969, 1971); Kumar and Udar (1985) made comprehensive studies on *Jamesoniella* Spruce (Schiffn.). Udar and Kumar (1981, 1982c) described *Jackiella javanica* Schiffn., *J. javanica* var. *cavifolia* Schiffn. and var. *cardifolia* Schiffn. from Eastern Himalayas and South India. The genera *Calypogeia* and *Metacalypogeia* are extensively studied in the contribution of Bischler (1970) and Sharma and Srivastava (1993). Grolle (1966a); Kitagawa (1966) provided an account of *Sphenobolus minutus* (Schreb *ex* Crants) Berg. and *Lophozia alpestris* (Schleich) Evans, respectively. Another, *Plagiochila* Dum. major genus of the Hepaticae containing *Plagiochila flexuosa* Mitt., *P. gollani* Steph., *P. firma* ssp. *firma* var. *firma* Inoue and var. *acicularis* Herz. were described from Eastern Himalayas (Inoue, 1960); Herzog (1930, 1950). Earlier account on the genus *Plagiochila* Dum. was provided by Mitten (1860-61); Heinrich *et al.* (1998) who made study on Neotropical species of *Plagiochila* Dum. Moreover, Inoue (1960, 1962, 1963, 1963a, 1964, 1964a, 1965, 1965a) made a series of publications on the Plagiochilaceae of South Eastern Asia. Amongst the series one of the publication of Inoue (1964a), separated out species *Plagiochilon fimbriatus* (Mitt.) Inoue for the status of another genus *Plagiochilon* Hatt. Moreover, Srivastava *et al.* (1994) and Srivastava and Dixit (1995) described *Plagiochila luthiana* Steph., *P. forficata* Schiffn. from Darjeeling and *P. phalangea* Tayl., *P. gollanii* Steph., *P. semidecurrens* (Lehm. *et* Lindenb.) Lehm. *et* Lindenb., *P. ferruginea* Steph., *P. nana* var. *robusta* Srivast. *et* Dixit, *P. vygensis* Steph., *P. mundalensis* Steph., *P. accedens* Steph., *P. chinensis* Steph. and *P. richteri* Srivast. *et* Dixit from Lilam in Kumaon, Western Himalayas.

Gottsche *et al.* (1844) and Stephani (1910) made study on the genus *Scapania* Dum. in India. Amakawa and Hattori (1954, 1954a); Amakawa (1964) made a short revisionary study on the Japanese and Himalayan *Scapania* Dum. including two new species *S. harae* Amak., *S. pseudoferruginea* Amak. from Darjeeling and *S. okamurana*

Steph. et Amak. from Darjeeling as new records for Himalayas. Srivastava and Srivastava (1993, 1995), described *S. orientalis* Steph., *S. ciliatospina* Harik., *S. parva* Steph., *S. verrucosa* Heeg., from Himanchal Pradesh and Kumaon district Uttar Pradesh. Members of the family Porellaceae are morphologically more variable and are commonly distributed in Eastern Himalayas, Western Himalayas and South India.

Hattori (1967, 1969, 1970, 1971) in a series of publications made studies on the Asiatic genus *Porella* L. Pocs (1968) described *P. plumosa* var. *hattoriana* Pocs from Khasi Hills, Meghalaya. Moreover, Udar and Shaheen (1983, 1983a) described *P. plumosa* Inoue and *P. hattorii* Udar et Shaheen from Western Himalayas, however Singh et al. (2001) provided the first information on the extended range of distribution of *P. hattorii* from western to eastern Himalayas region. Castle (1968) in a synopsis on the taxonomic revision of the genus *Radula* (L.) Dum. described various species of *Radula* (L.) Dum. from the world. However, Yamada (1979) made a comprehensive and revisionary study on the Asian taxa of *Radula*.

The family Frullaniaceae represents a large and complex group of *Frullania* comprising 58 species in India (Chopra, 1943); Parihar (1961-62); Parihar et al. (1994). Verdoorn (1930, 1934) made comprehensive study on genus *Frullania* Raddi and published a monograph on Indo-Malayan Frullaniaceae and Jubulae. Hattori (1972, 1973, 1973a, 1973b, 1974, 1974a, 1975, 1975a, 1975b, 1976, 1976a, 1980) made study and published a series of papers on the Asiatic species of the genus *Frullania* Raddi. Moreover, Nath (1977) made study on Indian Frullaniaceae (see Ph.D. thesis). Udar and Nath (1979, 1984) made study on the oil bodies of *Frullania* Raddi and species with entire amphigastria, respectively. Nath and Asthana (1998) described twelve species of *Frullania* i.e. *F. acutiloba* Mitt., *F. apiculata* Nees, *F. campanulata* Sde. Lac., *F. inflexa* Mitt., *F. gaudichaudii* (Nees et Mont.) Nees et Mont., *F. intermedia* (R. Bl. et Nees) Dum., *F. muscicola* Steph., *F. neurota* Tayl., *F. serrata* Gott., *F. squarrosa* (R. Bl. et Nees) Dum., *F. tamarisci* (L.) Dum. and *F. wallichiana* Mitt. from South India. Nath and Singh (2006) investigated a new taxa *Frullania udarii* sp. nov. from Meghalaya. Moreover, Udar and Nath (1978) also discovered a new species *Jubula hattorii* Udar et Nath from Darjeeling.

Another, family Lejeuneaceae, a large essentially tropical family has been divided into various genera by Evans (1939). In the history of the taxonomy of the Lejeuneaceae, the Hepaticae Amazonicae et Andinae by Spruce (1884-85) as an epoch making work and may be likened to a big building erected in the wilderness (Mizutani, 1961). In 1895 Schiffner (See Dixon et al., 1932) raised Spruce's subgenera to generic rank and accepted a total of forty genera. Moreover, Stephani (1900-1924) described about 2000 species under the family Lejeuneaceae. In addition, Evans (1902-12) described eight new genera in Puerto Rican Lejeuneaceae. Evans (1935) published "The anatomy of the stem in the Lejeuneaceae" which has become backbone in classification of Lejeuneaceae. Mitten (1860-61) described *Lejeunea laeviscula* Mitt. from Sikkim Himalayas and *Lejeunea subopaca* Mitt. from Khasi Hills (Eastern Himalayas), which are now treated under *Cheilolejeunea* (Spruce) Schiffn. (Stephani, 1914; Benedix, 1953; Mizutani, 1961). Mizutani (1964, 1967a, 1972); Thiers (1992), Hattori (1966); Asthana et al. (1995) made taxonomic studies on the genus *Cheilolejeunea* in India. The study on *Cololejeunea* (Spruce) Schiffn. was also made by Mizutani (1961); Amakawa and Shimose (1965); Udar and Srivastava (1982, 1983); Udar et al. (1985, 1986) and Srivastava and Srivastava (1989). Moreover, Agarwal and Srivastava (1985) described *Anomalolejeunea pluriplicata* (Pearson) Schiffn. from Jowai Meghalaya.

The genus *Lejeunea* particularly in India was described by Mizutani (1971). He enumerated 12 species of *Lejeunea*: *L. flava* (Sw.) Nees, *L. princeps* (St.) Mizut., *L. nepalensis* Steph., *L. subacuta* Mitt., *L. tuberculosa* Steph., *L. curviloba* Steph., *L. ulicina* (Tayl.) Tayl. from Meghalaya and *L. bidentula* Herz., *L. cavifolia* (Ehrh.) Lindb., *L. curviloba* Steph., *L. discreta* Lindenb., *L. stevensiana* (Steph.) Mizut. and *L. wallichiana* Lehm. from Nepal, Sikkim, Darjeeling, Assam and Mussoorie regions. Moreover, Mizutani (1961, 1963, 1964, 1970, 1972, 1972a, 1976, 1979) described various species of the genus *Lejeunea*. Udar and Awasthi (1981) investigated *Lejeunea indica* Udar et Awasthi from Darjeeling. Srivastava and Parihar (1986); Singh and Nath (2007a) described *Lejeunea cocoes* Mitt. from Western and Eastern Himalayas respectively. *Leucolejeunea* Evans was described by Evans (1907). Mizutani (1961) described *L. xanthocarpa* (L. & L.) Evans, *L. paroica* Kitagawa, and *L. japonica* (Horik.)

Verd. from Japan and Formosa. Udar and Nath (1975); Udar and Awasthi (1983) described *L. xanthocarpa* from South India, *L. turgida* and *L. paroica* from Sikkim Himalayas and Meghalaya. Genus *Spruceanthus* Verd. in India was described by Mizutani (1961) containing *S. polymorphus* (Sande. Lac.) Verd. and *S. semirepandus* (Nees), Verd. Udar and Awasthi (1982) described *S. polymorphus* from South India. *Ptychanthus striatus* (L. & L.) Nees was described by Mizutani (1961) from Assam; Parihar *et al.* (1994) listed this taxon from Western Himalayas, Eastern Himalayas, South India, Central India and Nepal. Awasthi and Udar (1984) described *Mastigolejeunea repleta* (Tayl.) Steph. from Khasi Hills Meghalaya and *M. humilis* (Gott.) Schiffn. from South India. *Brachiolejeunea sandivicensis* (Gott.) Evans was described by Mizutani (1961) from India. Parihar *et al.* (1994) listed *B. infuscata* (Mitt.) Schust. *et* Kachroo and *B. sandivicensis* (Gott.) Evans from Eastern Himalayas and South India, respectively. However, Verdoorn (1934) transferred these two species under *Trocholejeunea* Schiffn. Therefore, there was not a single representatives of *Brachiolejeunea* genus known from India so far. *Dicranolejeunea* (Spruce) Schiffn. is represented in India by three species. Mizutani (1980) described *D. gilva* Steph. from Khasi and Jaintia Hills; *D. javanica* Steph. from Java and *D. yoshinagana* (Hatt.) Mizut. from Japan. Parihar *et al.* (1994) listed former two species from Eastern Himalayas and latter from South India. Mizutani (1961, 1976, 1979) made study on the genus *Lopholejeunea* (Spruce) Schiffn. and described *L. sikkimensis* Steph. from Cherrapunji Meghalaya and Sikkim. Udar *et al.* (1983) described *L. gradsteinii* Udar *et al.*, which now has been synonymized under *L. abortiva* (Mitt.) Steph., Awasthi *et al.* (1999). Udar and Awasthi (1983a) investigated a new species *L. indica* Udar *et* Awasthi from Jowai Meghalaya. In a recent publication Awasthi *et al.* (1999) described twelve species of *Lopholejeunea* i.e. *L. abortiva* (Mitt.) Steph., *L. abortiva* var. *doliiformis* Awasthi *et al.*, *L. applanata* (R. B. & N.) Schiffn., *L. indica* Udar *et* Awasthi, *L. javanica* (Nees) Schiffn., *L. kashyapii* Awasthi *et al.*, *L. nicobarica* Steph., *L. nigricans* (Lindenb.) Schiffn., *L. nilgiriensis* Awasthi *et al.*, *L. sikkimensis* Steph., *L. sikkimensis* var. *dentata* Awasthi *et al.* and *L. subfusca* (Nees) Steph. Genus *Drepanolejeunea* Steph. in India was described by Udar and Awasthi (1982a). Udar and Awasthi (1979, 1982b) described *Leptolejeunea sikkimensis* Udar *et* Awasthi and *L. foliicola* Steph. from Sikkim Himalayas and Khasi Hills Meghalaya, respectively.

Along with acrogynous Jungermanniales, the anacrogynous *Jungermannia* were given attention by various workers. Kashyap (1915a) described *Fossombronia himalayensis* Kash. from Western Himalayas. Udar and Srivastava (1969) described *F. cristula* Aust. Moreover, Srivastava and Udar (1975a) made comprehensive study on the genus *Fossombronia* Raddi in India. Kashyap (1915a) described a monotypic genus *Sewardiella* Kashyap with a single species *S. tuberifera* (Kash.). Kashyap (1928) described *Petalophyllum indicum* Kash. from Western Himalayas. Kashyap (1917, 1929) described *Pellia calycina* (Tayl.) Nees; *P. epiphylla* (L.) Lindb and *P. neesiana* from Western Himalayas. *Pallavicinia canarus* Steph. in India was described by Pande and Srivastava (1953) which was further studied and synonymized under *P. lyellii* (Hook.) Gray, Srivastava (1961). Kachroo (1956) described *P. ambigua* (Mitt.) Steph., *P. lyellii* (Hook.) Gray from Assam.

Family Metzgeriaceae has been given adequate attention by various workers. Gola (1914) described *Metzgeria pubescence* Raddi and *M. conjugata* Lindb. from Western Himalayas. Kashyap (1917) investigated *M. himalayensis* Kash. from Western Himalayas. Herzog (1939a) instituted *M. crispula* Herz. from Eastern Himalayas. Kuwaha (1965, 1965a, 1969, 1975) described various species of the genus *Metzgeria* from Eastern Himalayas. Srivastava and Udar (1975) made monographic studies on the Indian Metzgeriaceae and described 11 species of *Metzgeria* viz. *M. pandei* Srivastava *et* Udar, *M. nilgiriensis* Udar *et* Srivastava, *M. indica* Udar *et* Srivastava, *M. madagassa* Steph., *M. lutescens* Steph., *M. crispula* Herz., *M. hamata* Lindb., *M. consanguinea* Schiffn., *M. conjugata* ssp. *japonica* Kuwah., *M. decipiens* (Massal.) Schiffn. *et* Gottsche and *M. himalayensis* Kash. from various localities of India.

Kashyap (1917, 1932a) described *Aneura indica* Steph. and *A. pinguis* (L.) Dum. from Western Himalayas. Pande and Srivastava (1958) described *Riccardia levieri* Schiffn. from India.

Schiffner *et al.* (1959) described *Riccardia palmatifomis* Schiffn. and *R. decolyana* Schiffn. from Kurseong Eastern Himalayas. Moreover, Srivastava (1972) described *R. platyclada* Gray from Pachmarhi in Satpura. Udar

and Srivastava (1973) instituted a new species *R. santapauii* Udar *et* Srivastava from Central India. Srivastava and Udar (1977) described *R. villosa* (St.) Pande *et* Srivastava from Khasi and Jaintia Hills Shillong. In a monographic study on Indian Aneuraceae, Srivastava and Udar (1976) described 8 species of *Riccardia* Gray viz. *R. tenuicostata* Schiffn., *R. villosa* (Steph) Pande *et* Srivastava, *R. cardotii* (Steph.) Pande *et* Srivastava, *R. sikkimensis* (Steph.) Pande *et* Srivastava, *R. levieri* Schiffn., *R. perssonii* Srivastava *et* Udar, *R. multifida* (L.) Gray and *R. santapauii* Udar *et* Srivastava and two species of *Aneura*: *A. pinguis* (L.) Dum. and *A. pellioides* (Horik.) Inoue. Singh (1966) described and gave illustrated account of seven species with the diversity and distribution of *Marchantia* L. em. Raddi. Singh (*l.c.*) accounted seven species of *Marchantia*: *M. polymorpha* L., *M. paleacea* Bert., *M. gemminata* Nees, *M. linearis* Lehm *et* Lindenb., *M. palmata* Nees, *M. assamica* Griff. and *M. subintegra* Mitt. Bischler (1989) enumerated *Marchantia paleacea* Bert. from India. Schiffner (1942) described *Exormothecca tuberifera* Kash. from Western Himalayas. Kashyap (1929) described *Dumortiera hirsuta* R.B. *et* Nees from Western Himalayas and South India. However, Srivastava and Sharma (1987) provided morphotaxonomic study on Indian *Dumortiera* species.

Members of the family Rebouliaaceae could be explored by Kashyap (1916, 1917, 1932). *Plagiochasma intermedium* Lindenb., *P. appendiculatum* L. *et* L., *P. articulatum* Kash. were described by Kashyap (1929) from Western Himalayas. A new species *P. pauciana* Udar *et* Chandra was instituted by Udar and Chandra (1964) from Western Himalayas. Kachroo (1954) described *P. appendiculatum* from Shillong Meghalaya, Western Himalayas and South India. Kashyap (1929) described *Reboulia hemispherica* (L.) Raddi from Western Himalayas. Moreover, Chandra (1963) and Udar and Chandra (1964) made study on the abnormal compound female receptacle in *R. hemispherica* collected from South India. Additionally, Udar and Chandra (1965) described two new species of the genus *Mannia* i.e. *Mannia forecae* Udar *et* Chandra and *Mannia personii* Udar *et* Chandra. Kashyap (1929) enumerated *A. angusta* (Steph.) Kachroo, *A. blumeana* (Nees) Kachroo, *A. pathankotensis* (Kash) Kachroo and *A. mussooriensis* (Kash.) Verdoorn under the name *Fimbriaria*. Mahabale and Bhate (1945) published the structure and life history of *A. angusta*. Moreover, Kachroo (1954a); Pande *et al.* (1954) described various species of *Asterella* from different regions. It was Mitten (1860-61) who first described *Targionia michelii* Corda from North West Himalayas. Kashyap (1929) illustrated *Targionia hypophylla* L. from Western Himalayas.

Genus *Cyathodium* Kunze was described with one new species *C. tuberosum* Kash. by Kashyap (1914) from Western Himalayas. Chavan (1937) described *C. barodae* Chavan from Baroda. Schiffner (1938, 1939) synonymized *C. barodae* Chavan under *C. smargdinum* Schiffn. and also described a new species *C. acrotrichum* Schiffn. from Kurseong Sikkim. Udar and Srivastava (1971) instituted *C. denticulatum* Udar *et* Srivastava from Darjeeling Eastern Himalayas. Recently, Srivastava and Dixit (1996) described 11 species of *Cyathodium* from various parts of the word. Singh (1982), Udar and Singh (1976) instituted *C. mehranum* Singh and *C. tuberculatum* Udar *et* Singh from Arunachal Pradesh and Darjeeling in Eastern Himalayas respectively.

Study on the Genus *Riccia* L. was previously made by Kashyap (1916) with description of four new species i.e. *R. cruciata* Kash., *R. robusta* Kash., *R. sanguinea* Kash. and *R. pathankotensis* Kash. Kashyap (1929), Ahmad (1942), Kachroo (1955) described various species of *Riccia*. Udar (1957), Pande and Udar (1957), Pande and Udar (1959) made study on the *R. discolor* L. *et* L., *R. gollani* Levies, *R. crispatula* Mitt., *R. frostii* Aust., *R. crystallina* L., *R. ciliata* Hoffm., *R. gangetica* Ahmad, *R. billardieri* Mont. *et* Nees, *R. beyrichiana* Hampe. and a new species *R. attenuata* Pande. Srivastava (1964) described various number of *Riccia* species with their distributional pattern in India.

Apart from the above, some systematic and regional bryophytes floras, checklists and census in India and abroad have also appeared. Chopra (1938, 1938a, 1943); Ahmad (1942); Gottsche *et al.* (1844); Griffith (1849, 1849a); Kashyap (1929, 1932); Herzog (1939a). Macvicar (1926); Parihar (1961-1962); Parihar *et al.* (1994); Bonner (1962, 1962a, 1963, 1963a, 1965, 1966); Bapna and Vyas (1962); Kachroo (1968, 1969); Kachroo and Schuster (1961); Stephani (1900-1924); Fry and Clark (1937-1947); Schuster (1953, 1966, 1969, 1974, 1980, 1983, 1984); Udar (1976); Verdoorn (1931, 1931a, 1932, 1933, 1935, 1938); Tewari and Pant (1994); Kumar (1995);

Gupta and Udar (1986); Sharma and Srivastava (1993); Bapna and Kachroo (1999); Nath and Asthana (2001); Srivastava and Srivastava (2002); Asthana and Srivastava (2003); Nair *et al* (2005) in liverworts, Asthana and Srivastava (1991) in hornworts and Gangulee (1969-1980) in mosses are some of the monumental work. Cavers (1910); Evans (1939); Grolle (1972) and Schuster (1983, 1984) made the way of classification to step the paddle of liverworts researches conveniently.

Present study contains taxonomic account of the liverworts in Khasi and Jaintia Hills Meghalaya. About 247 species, under 59 genera belonging to 23 families have been described with their taxonomic details, linedrawing illustrations, photographic plates and distributional maps. The present study is representing an addition of more than 166 species to the previously known liverworts to the bryoflora of this region and 10 new species for science. In present work the taxonomic treatment of each taxon and taxonomic categories are very convenient and are based on Evans (1939) classification systems of hepaticae. The contents of the taxonomic observations are composed of families which are further divided into genera and each genus into species on the basis of characteristic features. Each taxonomic rank like genus and species are arranged considering contrast characters using indented keys. In addition to these characteristic features the morphological as well as anatomical line drawing illustrations are also provided in support of the above features, which will support to the researchers and scholars of hepaticology to easily identify each taxonomic rank. The habitat and ecology included, provides knowledge of the occurrence, distribution and required optimum environmental conditions for growth and development of bryophytes.

Additionally, the discourses also have been made on the scope and application of hepatic flora, rare and endangered liverworts, conservation of liverworts, bryophytes as pollution indicator, as medicines, source of active chemical components, bryophytes and antimicrobial activity, bryophytes and ethnobotany and other potentials of bryophytes. These brief informations will be helpful to further excel research work on various aspects like molecular biology, conservation biology, taxonomy, ethnobotany and field biology of bryophytes. Thus this bryophytic flora including basic informations on importance and utility of bryophytes in Meghalays: Eastern Himalayas is the first attempt. This is the first attempt at a realistic analysis of the liverworts of any restricted temperate bryogeographical region in the Indian subcontinent after Kashyap (1929, 1932).



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