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## **A STUDY OF MOSS DIVERSITY IN ASSAM VALLEY WET EVERGREEN FORESTS**

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### **ABSTRACT**

The present study deals with the enumeration of 127 species of Mosses under 71 genera belonging to 27 families from the Assam Valley Wet Evergreen forests, Assam, India. Among the taxa *Pleuridiella colei* Robins. and *Splachnobryum synoicum* Robins are endemic to the present study area. Besides, an anisoporous moss *i.e.* *Macromitrium moorcroftii* (Hook & Grev.) Schwagr recorded in this study which is to be considered as noteworthy contribution towards the evolutionary significance corresponding with heterospory in Pteridophytes. It is the first ever work done as an Indian worker from the present political territory of Assam, India. In this investigation, it has been revealed that the order Hypnobryales consists of 49 species which is 62.23% of the total species recorded in this study. Taxonomically, the order Hypnobryales of Mosses is corresponded to the order Asterales of Dicotyledons of Angiosperms (Chopra, 1975). Considering this statement, most of the workers (Gogoi, 1981; Sarmah, 1989) of floristic study of Angiosperms from the present study area have also agreed with because the taxa under the order Asterales have shown highest diversity and even leading to the level of varieties. The present investigation on the Mosses recorded with 62.23 % of Hypnobryales of total species occurrence is of good corresponds with the Angiospermic order Asterales. Phytogeographically, the present study area considered as Assam Valley Wet Evergreen Forest type under “Tropical and Subtropical Evergreen Forests” (Mehra, *et. al.* 1983). As the tropical rain forests are at the core of modern biological research it should be conserved *in situ* which is a new challenge towards the sustainable development of the whole biological diversity as well as biological spectrum; otherwise many of the species of mosses and also other biological diversity would be perished and disappear before being documented from such potentially wilderness areas.

**Key Words:** Moss, Hypnobryales, Asterales, Tropical Rain Forest, Endemic, Anisoporous

### **INTRODUCTION**

Mosses are considered to have largest number of species among the green plants, next to the angiosperms of the plant kingdom (Chopra, 1975). However, the taxonomic studies on these elegant groups of plants have received little attention in the present study area. East and Southeast Asia (not including the Indian sub continent) are extremely rich and diverse in bryophyte taxa, especially in mosses. China, Siberia, Indochina and Archipelagic South Asian countries are very diverse in topography, climate and vegetation. The result is vast array of bryological diversity (Hallingback and Hodgetts, 2000). However; considering this statement, the present study have revealed a good number of species diversity of mosses which area falls under the Indian sub continent. The study area includes many protected areas like Biosphere Reserves, National Parks, Wildlife Sanctuaries, and Reserve Forests. They still represent more or less unfragmented floristic composition, which have extraordinary varied and rich moss diversity in varied climatic conditions. The general vegetation of the present study area has been influenced by the Eastern Himalayas as it is adjacent to the foot hills of it which is considered as a Hot Spot of the 12 mega biodiversity of the world. Phytogeographically, the present study area is considered as Assam Valley Wet Evergreen Forest type of “Tropical and Sub- Tropical Evergreen Forests” (Mehra, *et.al.* 1983). Tropical rain forests are the ideal home for Bryophytes because of their diverse microclimate and the variety of substrata available for the growth of this elegant group of plant kingdom. The microhabitat of moss communities are determined by the different amounts of direct or indirect light and heat radiation and by

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the availability of water and nutrients from direct rainfall, through fall, stem flow, mist, dew and in the form of ground water. All of these are influenced by the relative humidity and by the physical and chemical characters of substrata such as roots, stems and leaves of living or dead plants, underlying rock and naturally and artificially distributed soil surface. Degradation of the fragile ecosystem of this region due to various reasons the population of Bryophytes are decreasing day by day. The need for more and more Bryophytic exploration in this very inadequately known parts of the such wet evergreen forest absolutely be essential; otherwise many of the species would perish and disappear before being documented from such unexplored / under explored and potentially wilderness areas. In the wet evergreen forests, water is continually present in adequate amounts accompanied by high relative humidity. Such as the distribution of sun light shows a very uneven pattern in the interior of such type of forest both vertically and horizontally and is often a limiting factor of Moss vegetations.

## **MATERIALS AND METHODS**

### **Study Area and Location**

The present study area, the Upper Brahmaputra Valley, Assam, India is situated in between 25.9 °-28.0° E latitude and 92.4 ° - 96.09° N longitude. The area comprises by the 8 (eight) administrative districts namely, Golaghat, Jorhat, Sivasagar, Dibrugarh, Tinsukia, Lakkimpur, Dhemaji and Sonitpur which covering an area 29,929 km<sup>2</sup> and is 34. 29% of the total area of the state Assam, India. As far as boundaries of the study area, in the north and east lies the state Arunachal Pradesh whereas in the west the districts Nowgaon, Darang, Karbi Anglong and North Chachar hills of the state Assam. Towards south the state Nagaland and district Karbi Anglong of the state Assam and entire study area is very nearest to Eastern Himalayas which is considered as mega Hotspot of biodiversity. The altitude of the entire area varies from 100 to 480 mean sea level. The average annual rainfall is 2500 mm; relative humidity is 89.8%; minimum and maximum temperature is 11°C and 38°C respectively.

### **Methods**

Thorough years round, collection of mosses covering all the seasons from various diverse habitats and localities were made randomly during the period extending from 2005 to 2009 and brought to the laboratory in blotting paper envelopes. The collected specimens are air dried, preserved and stored in suitable well labeled standard sized packets as well as in liquid preservation in 70% alcohol. They were worked out in the laboratory and identified consulting with the standard literatures. The identified taxa have deposited to the Lichenological and Bryological sections of Debraj Roy College Herbarium, Golaghat, Assam, India.

## **RESULTS**

In our investigations, we have recorded total of 127 taxa of mosses under 71 genera belonging to 27 families including two endemic species viz. *Pleuridiella colei* Robins, and *Splachnobryum synoicum* Robins. In considering the taxa at order level, the present studies have revealed that the order Hypnobryales consists of 49 species which is 62.23% of the total species recorded in our investigations (Table 1). The taxa under the order Hypnobryales have been considered as recent origin and probably still evolving in tropical rain forests (Gangulee, 1985). As the present study site falls under Assam Valley Wet Evergreen Forest Types of “Tropical and Subtropical Evergreen Forests”, our investigation have also revealed the highest diversity under the order Hypnobryales (Table 2).

## **DISCUSSION**

The position of the order Hypnobryales amongst the pleurocarpous mosses are corresponds to the order Asterales of Dicotyledons of Angiosperms. In consideration of taxonomic and floristic studies have revealed that in these groups process of speciation is still taking place and some of the features of taxa under these groups have not yet been stabilized (Chopra, 1975). Considering this statement, most of the

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workers (Gogoi 1982; Sarmah 1989 etc) of floristic study of Angiosperms from the present study area have also agreed with because the taxa of the Asterales have been shown species diversity as well as

**Table 1: Statistical analysis of the Taxa.**

Orders	Families	No. of Genus	No. of species	% of the occurrence	Total species
				under a family	under a order
1. Polytrichales	Polytrichaceae	3	3	3.81	3.81
2. Dicranales	Wilsoniellaceae	1	1	1.27	30.48
	Ditrichaceae	5	5	6.35	
	Dicranaceae	7	15		
	Leucobryaceae	3	3	3.81	
3. Fissidentales	Fissidentaceae	1	14	17.78	17.78
4. Syrrhopodontales	Calymperaceae	3	7	8.89	8.89
5. Pottiales	Pottiaceae	6	8	10.16	10.16
6. Funariales	Funariaceae	1	3	3.81	5.08
	Splachnaceae	1	1	1.27	
7. Eubryales	Bryaceae	2	5	6.23	7.62
	Bartramiaceae	1	1	1.27	
8. Isobryales	Erpodiaceae	1	1	1.27	11.43
	Orthotricaceae	1	1	1.27	
	Pterobryaceae	1	1	3.81	
	Meteoriaceae	2	3	2.54	
	Neckeraceae	2	2	2.54	
9. Hookeriales	Hookeriaceae	3	3	3.81	3.81
10. Hypnobryales	Fabroniaceae	1	1	1.27	62.23
	Thuidiaceae	4	9	11.43	
	Amblystegiaceae	1	1	1.27	
	Brachytheciaceae	3	5	6.35	
	Entodontaceae	4	4	5.08	
	Plagiotheciaceae	1	3	3.81	
	Sematophyllaceae	6	9	11.43	
	Hypnaceae	6	16	20.32	
	Hylocomiaceae	1	1	1.27	

Total = 27 71 127

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**Table 2: Species Diversity of Mosses recorded in the present study area.**

Orders	Families	Name of the taxa
Polytrichales	Polytrichaceae	* <i>Lyellia crispa</i> R. Brown, <i>Pogonatum aloides</i> (Hedw.) Beauv., * <i>Polytrichum piliferum</i> Hedw.
Dicranales	Wilsoniellaceae	* <i>Wilsoniella decipens</i> (Mitt.) Alston.
	Ditrichaceae	* <i>Ceratodon stenocarpus</i> Bruch et Schimp., * <i>Distichium capillaceum</i> (Hedw.) B.S.G., * <i>Ditrichum homomallum</i> (Hedw.) Hampe., * <i>Garckea abbreviata</i> Dix. et P. Verd. <i>Pleuridiella colei</i> Robins.
	Dicranaceae	* <i>Campylopodium griffithii</i> (Mitt.) Mitt. ex. Broth., * <i>Campylopus ericoides</i> (Griff.) Jaeg., * <i>C. laetus</i> (Mitt) Jaeg., * <i>C. subgracilis</i> Ren et Card. ex Gangulee, * <i>C. richardii</i> Brid. * <i>Dichodontium pellucidum</i> (Hedw.) Schimp., * <i>Dicranella divericata</i> (Mitt.) Jaeg. * <i>D. heteromalla</i> (Hedw.) Schimp * <i>D. spiralis</i> (Mitt.) Jaeg., * <i>Dicranodontium caespitosum</i> (Mitt.) Paris, * <i>Dicranum kashmirensis</i> C. Muell., * <i>D. lorifolium</i> Mitt. * <i>Trematodon ceylonensis</i> C. Muell., * <i>T. hookeri</i> C. Muell., * <i>T. kurzii</i> Hampe ex Gangulee.
	Leucobryaceae	* <i>Leucobryum bowringii</i> Mitt., <i>Leucophanes octoblepharoides</i> Brid., <i>Octoblepharum albidum</i> Hedw.
Fissidentales	Fissidentaceae	* <i>Fissidens auriculatus</i> C. Muller., * <i>F. bilaspurensis</i> Gangulee, * <i>F. bryoides</i> (L.) Hedw., <i>F. diversifolius</i> Mitt., * <i>F. incognitus</i> Gangulee, * <i>F. involutus</i> Wills et. Mitt., * <i>F. lancifolius</i> Hampe ex Gangulee, * <i>F. nobilis</i> Griff., * <i>F. pulchellus</i> Mitt., * <i>F. ranchinensis</i> Gang., * <i>F. rubricaulis</i> Dix.,

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		* <i>F. subpalmatus</i> C. Muller, * <i>F. teraicola</i> C. Muller, * <i>F. titalyanus</i> C. Muller.
Syrhropodontales	Calymperaceae	* <i>Calymperes burmense</i> Hampe, * <i>C. hampei</i> Dozy et. Molk., * <i>C. heterophyllum</i> ( Mitt.) Bescherella, * <i>C. tenerum</i> C. Mueller, * <i>Syrhopodon gardneri</i> (Hook.) Schw., * <i>Thyridium fasciculatum</i> ( Hook. et Grev.) Mitt., * <i>T. piluliferum</i> (Dix.) Gangulee.
Pottiales	Pottiaceae	* <i>Anoetangium thomsonii</i> Mitt., * <i>Barbula constricta</i> Mitt., * <i>Hydrogonium arcuatum</i> (Griff.) Wijk et Marg., * <i>H. inflexum</i> (Dub in Morotzi) Chen., * <i>H. leucodontoides</i> Gangulee, * <i>Hyophila involuta</i> (Hook.) Jaeg., * <i>Pseudosymblepharis pallidens</i> Dix. * <i>Tortella tortuosa</i> (Hedw.) Limpr.
Funariales	Funariaceae	* <i>Funaria diversinervis</i> ( C. Muell.) Broth., * <i>F. hygrometrica</i> Hedw., * <i>F. wichurae</i> ( Fleisch) Broth.
	Splachnaceae	<i>Splachnobryum synoicum</i> Robins.
Eubryales	Bryaceae	* <i>Bryum capillare</i> L. ex. Hedw., * <i>B. cellularae</i> Hook., * <i>B. coronatum</i> Schw., * <i>B. hemisphericarpum</i> C. Muller., * <i>Pohlia ampulacea</i> Gangulee.
	Bartramiaceae	<i>Philonotis revoluta</i> Bosch et Lac.
Isobryales	Erpodiaceae	* <i>Erpodium mangiferae</i> C. Muell.
	Orthotricaceae	* <i>Macromitrium moorcroftii</i> (Hook. et Grev.) Schw.
	Pterobryaceae	* <i>Pterobryopsis auriculatus</i> Dix., * <i>P. crassicaulis</i> (C. Muell.) Fleisch., * <i>P. divergens</i> ( Mitt.) Jaeg.
	Meteoriaceae	* <i>Aerobryopsis longissima</i> (Doz et Molk.) Fleisch. * <i>Barbella stevensii</i> (Ren et Card.) Fleisch.
	Neckeraceae	* <i>Neckera crenulata</i> Harv., * <i>Thamnobryum fruticosum</i> (Mitt.) Gangulee.
Hookeriales	Hookeriaceae	* <i>Callicostella papillata</i> (Mont.) Mitt.,

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		<i>Chaetomitrium papillifolium</i> Bosch., * <i>Eriopus lucidus</i> Chwit et Mitt.
Hypnobryales	Fabroniaceae	* <i>Fabronia secunda</i> Mont.
	Thuidiaceae	* <i>Anomodon minor</i> ( Hedw.) Lindb., Ssp. <i>integerrimus</i> ( Mitt.) Iwats., * <i>Claopodium assurgens</i> (Sull et. Lesk.) Card., * <i>Herpetineuron toccoae</i> (Sull et. Lesk.) Card., * <i>Thuidium brotheri</i> Salm., * <i>T. kiasense</i> Williams, * <i>T. koelzii</i> Robins, * <i>T. meyanianum</i> (Hampe) Doz et. Molk., * <i>T. philbertii</i> Limp., * <i>T. subpellucens</i> Dix.
	Amblystegiaceae	* <i>Campylium lacerulum</i> (Mitt.) Broth.
	Brachytheciaceae	* <i>Brachythecium laevi-velutinum</i> Dix., * <i>B. rivulare</i> B.S.G., * <i>Eurhynchium dumosum</i> (Mitt.) Jaeg., <i>Rhynchostegium celebicum</i> (Bosch. et Lac.) Jaeg., * <i>R. hookeri</i> Jaeg.
	Entodontaceae	* <i>Erythodontium julacium</i> ( Schw.) Par., * <i>Orthothecium intricatum</i> (Hartm.) B.S.G., * <i>Pterygynandrum decolor</i> (Mitt.) Broth., * <i>Trachyphyllum inflexum</i> (Harv.) Gepp.
	Plagiotheciaceae	<i>Stereophyllum anceps</i> ( Bosch. et Lac. ) Broth., * <i>S. indicum</i> (Bel.) Mitt. * <i>S. wightii</i> (Mitt.) Jaeg.
	Sematophyllaceae	* <i>Acanthorrhyncium papillatum</i> ( Harv.in Hook.) Fleisch., * <i>Brotherella falcata</i> ( Doz. et. Molk.) Fleisch., * <i>Foreaulla orthothecia</i> ( Schw. ) Dix. et Vard., <i>Meiothecium microcarpum</i> (Hook.) Mitt., <i>Sematophyllum subhumile</i> (C. Muell.) Fleisch., * <i>Taxithellium cellatum</i> ( Mitt.) Broth., * <i>T. kerianum</i> ( Broth.) Broth., * <i>T. laeviusculum</i> Dix., * <i>T. nepalensis</i> ( Schw.) Broth.
	Hypnaceae	* <i>Ectropothecium buitenzorgii</i> (Bel.) Mitt., * <i>E. ramuligerum</i> Dix., * <i>Hypnum cupressiforme</i> Hedw., * <i>Isopterygium banacanum</i> (Lac. ) Jaeg., * <i>I. distichaceum</i> ( Mitt. ) Jaeg.,

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		<i>I. minutirameum</i> ( C. Muell.) Jaeg., * <i>I. pallidulum</i> (Mitt.) Jaeg., * <i>I. seligeri</i> ( Brid.) Dix., * <i>Ptilium crista-castrensis</i> (Hedw.) De Not., * <i>Taxiphyllum taxirameum</i> ( Mitt.) Fleisch., * <i>Vesicularia levieri</i> Card., * <i>V. montagnei</i> ( Bel.) Broth., * <i>V. perreticulata</i> Broth., * <i>V. reticulata</i> (Doz. et Molk.) Broth., * <i>V. selaginelloides</i> Dix., * <i>V. subpilicuspis</i> Card et P. Vard.
	Hylocomiaceae	* <i>Macrothamnium macrocarpum</i> (Reinw. et Hornch.) Fleisch.

\*First report from Assam Valley Tropical Wet evergreen Forests, Assam, India.

leading to variety from this region. In our investigation on mosses recorded with 62.23% of Hypnobryales of total species occurrence is of good corresponds with the order Asterales of Angiosperms.

Moreover, among the taxa we have collected *Pleuridiella colei* Robins. and *Splachnobryum synoicum* Robins. are considered as endemic to the present study area. These two species had collected by Arther C. Colei, a military officer while on duty in Upper Assam during World War II and deposited to the Smithsonian Institution, Washington D. C., USA; where those were identified (Robinson, 1964). In our literature consultation, we have noticed that these two taxa have never been collected anywhere from our country as well as anywhere from the World. Moreover, during our critical laboratory studies we have noticed an anisosporous moss *Macromitrium moorcroftii* (Hook. & Grev.) Schwagr. is also a noteworthy contribution towards the evolutionary point of views corresponding with heterospory in Pteridophytes.

Besides, in our collections during field trips in the different forests areas of the study sites, there are a lots of species have yet to be identified. We hope, among them the *sp novo* will certainly be established.

In order to find such records our first step should be conservation of rain forests. It has been also possible to find new species (*Sp novo*) if the exploration will be carried out in detail of the rain forests situated in the administrative district Dibrugarh and Tinsukia, particularly proposed Joydihing wildlife sanctuary and Dibru-Saikhowa Biosphere Reserve. As the mosses are to be considered as integral part of the ecosystems, those cannot be conserved in isolated patches by establishing artificial moss garden. Therefore, conservation should be *in situ*. It is a new challenge towards the concept of sustainable development of the whole biological diversity as well as biological spectrum.

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