

## Bryoflora of District Rajouri - Jammu and Kashmir State, India

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### ABSTRACT:

District Rajouri harbours a rich floral and faunal diversity besides varying climatic zones namely sub-tropical, temperate and alpine. The region exhibit significant altitudinal variations ranging from 490 m. to 4700 m. The present study was conducted to report bryophytic elements of the study area as there is no previous work done on this aspect from the study area, except some stray references. A total of 44 bryophyte species belonging to 4 orders, 16 families and 21 genera were reported from the study area. A checklist of the reported plant species with family, distributional range and habitat is presented in the paper. Besides contributing to the regional and national biodiversity check list database, the present study has opened up a new window for the future studies on the various aspects of the reported taxa including extensive exploration for the updation of the present list and to study the conservational aspects of the disappearing bryoflora of the region.

**KEY WORDS:** Rajour, Bryophytes, Bryoflora, Vegetation, Checklist

### INTRODUCTION

Bryophytes contain 18500 species and nearly 1050 genera worldwide (Oren *et al.* 2007) They are pioneers of the terrestrial vegetation. Bryophytes are of immense ecological and high aesthetic value. They grow in variety of life forms contributing to the main component of mountane forest due to high degree of soil binding capacity besides the water retention characteristics (Alam, 20011, Smith 1982) Currently, about 2489 taxa of bryophytes (including interspecific taxa), comprising 1786 species in 355 genera of mosses, 675 species in 121 genera of liverworts and 25 species in six genera of hornworts are reported from India (Dandotiya *et al.*, 2011).

Stephani (1900-1924) provided the first organized account of the hepatics of Kashmir followed by Gola (1914) reporting eleven species of liverworts from Kashmir valley. Kashyap ((1929, 1932) recorded twenty two hepatic taxa from Kashmir valley and nine from Ladakh region. Robinson (1965) compiled the first checklist of the bryophytic elements of Kashmir Valley, and reported fifty six moss and four liverwort species. Kaul and Dhar (1968) reported a total of thirty five species of bryophytes from the Kashmir valley. Kachroo (1970), Srivastava

(1979), Banday (1997) and Banday *et al.* (1998) also made significant contributions to the bryoflora of Kashmir valley. Tanwir (2000), Langer and Tanwir, (2002), Gupta (2002), Langer and Fardos, (2002), Langer *et al.*, (2003), Tanwir and Langer (2003), Tanwir and Langer, (2004), Tanvir (2005), Tanwir and Langer (2006), Tanwir and Langer (2008) Iqbal *et al.* (2011) Sharma *et al.* (2011) and Bhagat *et al.* (2012) studied some important aspects of the bryoflora of Jammu region including exploration and enumerations. However not even a single report has been published from the study area, which otherwise harbor quite rich plant diversity. To cover the knowledge gap and keeping in view the need for generation of floral diversity lists as these are the most important tools for species and ecosystem conservation, taxonomic studies and other aspects, present study was undertaken in district Rajouri.

## MATERIALS AND METHODS:

### 1. Study Area and Methods:

Rajouri is one of the hilly districts of Jammu and Kashmir State bounded by district Poonch in North, district Jammu in South, district Udhampur in East and PoK (Mirpur) in the West. The district lies between  $30^{\circ} - 50' N$  to  $33^{\circ} - 30' N$  longitude and  $74^{\circ} E$  to  $74^{\circ} - 10' E$  latitude, covering an area of  $2630 \text{ km}^2$  with an altitudinal variation of 490 m. in Sunderbani to 4700 m. in Pir Panjal ranges. District Rajouri has six tehsils and nine blocks with four small towns, having an urban area of  $18 \text{ km}^2$  (Figure.No.1.) The present work is the outcome of extensive survey of district Rajouri undertaken during 2007 and 2010. Field surveys were undertaken during different seasons. The collected plant material was press dried in papers and used for making the Voucher Specimen deposited with the Herbarium of department of Botany, University of Jammu and at EFI Taxonomic Laboratory, Jammu. The identification of species has been done by consulting various flora, monographs and publications. Schuster (1984), Asthana and Srivastava (1991), Zhu (2005) and Daniels (2010) have been followed for the placement of the reported elements. The reported plant species are arranged alphabetically within the families. Each species is listed with author citation, followed by the distributional range and habitat. A large number of specimens are still in the process of identification and proper placement. Moss elements have not been included in the list to avoid confusion and presentation complications and shall be discussed in the future updates.

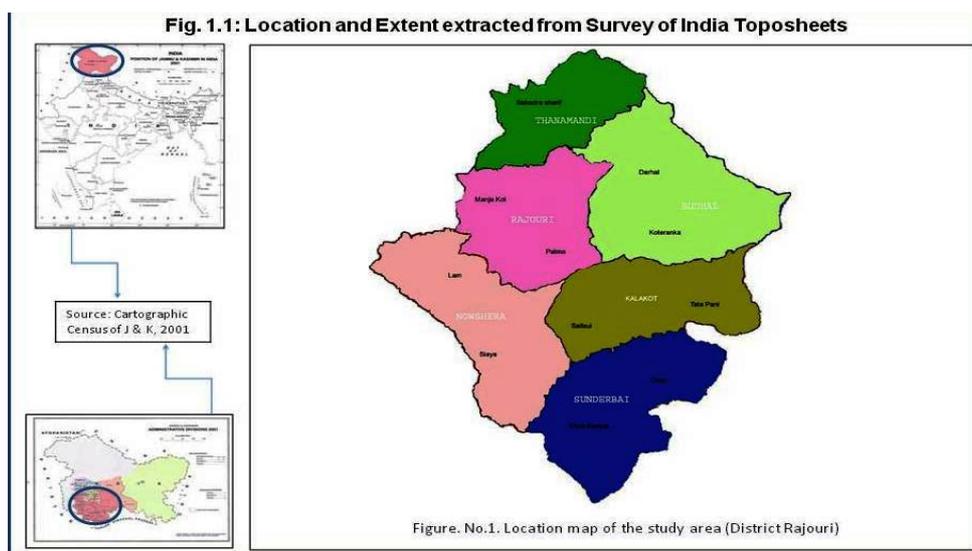


Figure No.1. Map of the Study Area.

## 2. Vegetation:

The vegetation of the Study Area (District Rajouri, J &K) varies from subtropical to temperate, subalpine and alpine, along an altitudinal gradient of 490-4750 m. On the basis of general specie composition, altitudinal range and the climate vegetation of the study area has classified into broad types as defined by Champion and Seth (1968) and modified wherever required according to local field conditions. The variation thus encountered in the vegetation is described below:

**1. Sub-tropical vegetation:** This type of vegetation is quite common in the foothills of Sunderbani, Nowshera and Kalakote tehsils. Also a part of the Rajouri tehsil exhibit the subtropical vegetation. Common tree elements of this region are, *Mallotus philippensis*, *Wendlandia heynei*, *Punica granatum*, *Ziziphus mauritiana*, *Bauhinia variegata*, *Phyllanthus emblica*, *Ziziphus mauritiana*, *Cassia fistula*, and the dominant shrubby species are *Dodonaea visosa*, *Adhatoda vasica*, *Woodfordia fruticosa*, *Erythrina indica*, and *Colebrookea oppositifolia*. Sub-tropical broad leaved deciduous forests are common at low altitude areas, mostly with eroded soil. Common herbs of this region are *Arisaema jacquemontii*, *Euphorbia hirta*, *Oxalis corniculata*, *Verbena officinalis*, *Amaranthus spinosus*, *Achyranthes aspera* and *Gagea elegans*. Another major vegetation type of the study area in sub-tropical zone is **Sub-tropical evergreen Chir-pine forest**. These forest are confined to an elevation of 900-1600m and common in Bindi Jamola, Manjakote and Gharati areas. Chir pine is the dominant tree species and at lower altitudes, is occasionally associated with other tree species like: *Albizia lebbeck*, *Quercus leucotrichophora*, *Pyrus pashia*, *Xanthoxylum alatum* and *Punica granatum*. This is a transition zone where the angiosperm-dominated sub-tropical forests are replaced by the gymnosperm dominated chir pine forest. The canopy of pines covers undergrowth of isolated shrubby patches, which include species of *Carissa opaca*, *Woodfordia fruticosa*, *Colebrookia oppositifolia*, and *Berberis lycium*. The common herbs found in this forest type are: *Taraxacum officinale*, *Argemone mexicana*, *Parthenium hysterophorus*, *Micromeria biflora*, *Geranium wallichianum*, *Epilobium wallichianum*, *Plantago lanceolata*, and *Achyranthes aspera*.

**2. Temperate Vegetation:** The vegetation above 1800 m is mostly temperate and based on the dominant species, species combination, soil, altitude and climate can be broadly categorized into four major type i.e. Deciduous broad leaved pure temperate forests, Deciduous broad leaved mixed temperate forests, Coniferous Temperate forests and Mixed temperate forests. The Deciduous broad leaved pure temperate forests are further of four types depending the dominant tree species. Two major types are: **a) *Lyonia ovalifolia* forest** found at an elevation of 1300-1500m in Sawari, Palma *Lyonia ovalifolia* is dominant and gregarious in habit rarely few other tree species like *Xanthoxylum alatum*, *Rhododendron arboretum* and *Quercus semicarpifolia* are also associated with it. The dominant shrubs of this forest type are: *Rosa burmonii*, *Sarcococca saligna*, *Urtica dioca*, *Berberis lycium* and *Rubus ellipticus*. Some common herbs in this forest type are: *Gerbera gossypina*, *Viola odorata*, *Tanacetum gracilis* and *Valeriana jatamansi*, *Valeriana dubia* and *Equisetum dubile*. **b) *Alnus nitida* forest** quite common from Dana to Darhal areas of the district Rajouri. 1270-1700m. These forests are present along both banks and islands of the river Sewa. At drier places, *Alnus nitida* is associated with *Celtis australis*, *Ulmus wallichiana* and *Populus ciliata*. The shrubs like *Rubus ellipticus*, *Prinsepia utilis*, *Sarcococca saligna*, *Buddleja paniculata*, and *Solidago canadensis* are commonly associated with this forest. Some of the dominant herbs are: *Ranunculus sceleratus*, *Rumex hastatus*, *Rumex nepalensis*, *Stellaria media*, *Gnaphalium luteoalbum*, *Epilobium wallichianum*, *Plantago major* and *Primula floribunda*. The deciduous broad leaved mixed temperate forests exists mainly in the **Coniferous Temperate forests are of** mainly two types and are evergreen forests, gregarious in habit and inhabiting an altitudinal range of 1400-3200 m flourish in the area of study. These are: **a) *Picea smithiana* forest growing luxuriantly** between 2000-2600m altitudes at Jari wala and on the way to Shakar Marg areas are occupied by this forest type. **b) *Abies pindrow* forest** found in Peedh

wala, Doda Mal, Phalwari and Dali areas at altitudinal range of 2200-2800m. The common shrubs in this forest are *Sarococca saligna* and *Daphne papyracea*. Herbaceous flora is scanty.

Depending upon the species composition, three different types of **mixed temperate forests** inhabit the study area. These are **a) *Pinus roxburghii* and *leucotrichophora* mixed forest** found between the altitudinal range of 1400-1800m Dodaj, Leeran, Kahteran, Bangi, Manjakote. **b) *Pinus wallichiana*, *Rhododendron arboretum* and *Quercus sp.* mixed forest** growing at an altitudinal range of 1700-2400m at Chilla, Mal bari, Topa. **c) *Picea smithiana* and *Abies pindrow* mixed forest growing** in the Northern Slopes in Jari wala, Doba, Pidh wala ranges at an altitudinal range of 2200-2800m.

**3. Sub-alpine and alpine vegetation:** The areas above 3500 m are heavily grazed and are mostly covered by herbaceous annuals and perennials forming alpine and subalpine vegetation. At places, on lower altitudes, some shrubby taxa are also present. The upper reaches remain snow bound for most part of the year, except during spring when they are full of herbaceous elements like *Androsace lanuginosa*, *Anemone obtusiloba*, *Bergenia stracheyi*, *Caltha palustris*, *Delphinium cashmerianum*, *Meconopsis aculeata*, *Parnassia nubicola*, *Polygonum offline*, *Potentilla ambigua*, *Primula denticulate*, *Saxifraga flagellaris*, and *Thymus serpyllum* besides shrubby taxa like *Juniperus communis*, *Juniperus recurva*, *Rhododendron anthopogon*, and *Rhododendron campanulatum*.

## RESULT AND DISCUSSION

The present study comprises of an account of 44 species under 21 genera, 16 families and 4 orders. Although this study is not very extensive, it shows that district Rajouri is a good abode of bryophyte flora. A brief account with relevant information on all the 44 species found in the region is given in the Table no.1. It is evident from the highly diversified geographical, climatic and floristic conditions that district Rajouri harbour rich bryodiversity. However, the area is still underexplored and the present study is the first ever preliminary attempt to bridge the gap. The aim of the study was to explore the bryophytic elements of the study area. The study may serve as valuable contribution to the knowledge of the bryoflora of India and gives a base for the future biodiversity studies. It has been observed that reported taxa are adapted to a wide range of habitats preferring shady, moist places of the plains or slope of hills in the study area. 25 of the reported species were found thriving in non-epilithic habitats, 24 species growing in epilithic conditions, 8 species in epiphytic habitats and 12 species were reported from both epilithic and non-epilithic habitats. 900 m. to 200 m. altitudinal range possessed the most number of reported taxa. Only 8 species were reported above the 2000 m. altitude. Aytoniaceae with 8 species was the dominant bryophytic family reported from study followed by Marchantiaceae with 6 species, Porellaceae and Plagiochilaceae with 5 species each. Jubulaceae, Lejeuneaceae and Ricciaceae represented 3 species each. Only 2 species each of Cleveaceae and Jungermanniaceae were reported. Aneuraceae, Conocephalaceae, Phaeocerotaceae, Pelliaceae, Radulaceae, Scapaniaceae and Targioniaceae were represented by single species each.

Field observations revealed that over the years rapid expansion of agricultural land, destruction of forests, execution of unplanned developmental activities and other anthropogenic factors have resulted in serious ecological imbalance and degeneration of biodiversity in this region which contributed in significant climate changes. The ongoing national projects including survey for the construction of Indian railways from Jammu to Poonch, widening of Jammup-Poonch highway, construction of one of the country's longest tunnel i.e. Pir ki Gali tunnel, construction of Mughal Road from Bafliaz up to Rajouri, unplanned construction of more than 400 km. road network during the last five years and many other factors have made district Rajouri vulnerable in terms of biodiversity loss and climate changes. The disturbances associated with these projects and countless number of other anthropogenic activities have made the region unfavourable for many endangered species of flora and fauna. The damage to bryophytic vegetation is greatest. Goats and sheep make trails through the forests, break the surface of the soil

with their hoofs and during rain fall loosened soil is washed away. Similarly, cows and particularly the heavy buffaloes break the soil of steep slopes by trampling and make tracks on the hill sides which form rivulets when rain falls. Slips are universal and unless something is done and done quickly to regulate the grazing and other anthropogenic activities, forest land and biodiversity of the region will be lost by erosion. Floods will increase in intensity and suddenness. Checklists are important tools in taxonomy, systematic and conservation studies. (Söderstrom *et al.* 2007, 2008). Keeping in view the need to update the regional and national biodiversity checklist register and to provide a database to the future researchers to start with, the present study was undertaken.

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**Table No.1.** Bryophytic elements reported from the study area (District Rajouri, Jammu and Kashmir-India). The reported taxa were enumerated under their respective families. (EP=Epilithic, NEP=Non-epilithic, EPH=Epiphytic)

**Name:** *Asterella angusta* (Steph.) Kachroo

Family: Aytoniaceae

Habitat: EP, NEP

Altitudinal range: 1500-2500m.

**Name:** *Asterella blumeana* (Nees) Pandé, K.P. Srivast. & Sultan Khan

Family: Aytoniaceae

Habitat: EP, NEP

Altitudinal range: 1200-2300 m.

**Name:** *Asterella reticulata* (Kashyap) Pandé, K.P. Srivast. & Sultan Khan

Family: Aytoniaceae

Habitat: EP, NEP

Altitudinal range: 1600-2000 m.

**Name:** *Athalamia pinguis* Falconer

Family: Cleveaceae

Habitat: EP, NEP

Altitudinal range: 1400-1800 m.

**Name:** *Athalamia pusilla* (Stephani) Kashyap

Family: Cleveaceae

Habitat: NEP

Altitudinal range: 1400-1800 m.

**Name:** *Conocephalum conicum* (L.) Underw.

Family: Conocephalaceae

Habitat: EP, NEP

Altitudinal range: 1000-2000 m.

ARCHIVE FOR BRYOLOGY 145 (2012)

**Name:** *Dumortiera hirsute* (Sw.) Nees

Family: Marchantiaceae

Habitat: EP, NEP

Altitudinal range: 1000-2000 m.

**Name:** *Frullania gaudichaudii* (Nees & Mont.) Nees & Mont.

Family: Jubulaceae

Habitat: EPH

Altitudinal range: 1300-1800 m.

**Name:** *Frullania muscicola* Steph.

Family: Jubulaceae

Habitat: EPH

Altitudinal range: 1300-1800

**Name:** *Frullania neurota* Taylor

Family: Jubulaceae

Habitat: EPH

Altitudinal range: 1300-1800 m.

**Name:** *Gymnocolea inflata* (Huds.) Dumort.

Family: Jungermanniaceae

Habitat: NEP

Altitudinal range: 900-1200 m.

**Name:** *Jungermannia lanceolata* L.

Family: Jungermanniaceae

Habitat: NEP

Altitudinal range: 900-1500 m.

**Name:** *Lejeunea aloba* Sande Lac.

Family: Lejeuneaceae

Habitat: EP

Altitudinal range: 800-1100 m.

**Name:** *Mannia foreau* Udar & V. Chandra

Family: Aytoniaceae

Habitat: NEP

Altitudinal range: 900-1500 m.

**Name:** *Marchantia kashyapii* Udar & Shaheen

Family: Marchantiaceae

Habitat: NEP

Altitudinal range: 1700-2500 m.

**Name:** *Marchantia nepalensis* Lehm. & Lindenb.

Family: Marchantiaceae

Habitat: NEP

Altitudinal range: 700-1800 m.

**Name:** *Marchantia palmate* Reinw., Nees & Blume

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Family: Marchantiaceae  
Habitat: NEP  
Altitudinal range: 700-1800 m.

**Name:** *Marchantia polymorpha* L.  
Family: Marchantiaceae  
Habitat: EP  
Altitudinal range: 700-2000 m.

**Name:** *Marchantia subintegra* Mitt.  
Family: Marchantiaceae  
Habitat: NEP  
Altitudinal range: 600-1700 m.

**Name:** *Pellia endiviifolia* (Dicks.) Dumort.  
Family: Pelliaceae  
Habitat: NEP  
Altitudinal range: 1300-1800 m.

**Name:** *Phaeoceros laevis* (L.) Prosk.  
Family: Phaeocerotaceae  
Habitat: NEP  
Altitudinal range: 900-2000 m.

**Name:** *Plagiochasma appendiculatum* Lehm. & Lindenb  
Family: Aytoniaceae  
Habitat: EP, NEP  
Altitudinal range: 900-2500 m.

**Name:** *Plagiochasma articulatum* Kashyap  
Family: Aytoniaceae  
Habitat: EP, NEP  
Altitudinal range: 900-2500 m.

**Name:** *Plagiochasma intermedium* Lindenb. & Gottsche  
Family: Aytoniaceae  
Habitat: EP, NEP  
Altitudinal range: 900-2500 m.

**Name:** *Plagiochila accedens* Steph.  
Family: Plagiochilaceae  
Habitat: EP, NEP  
Altitudinal range: 700-2000 m.

**Name:** *Plagiochila chinensis* Stephani  
Family: Plagiochilaceae  
Habitat: EP  
Altitudinal range: 700-2000 m.

**Name:** *Plagiochila parvifolia* Lindenb.  
Family: Plagiochilaceae

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Habitat: EP  
Altitudinal range: 600-1800 m.

**Name:** *Plagiochila phalangea* Taylor.  
Family: Plagiochilaceae  
Habitat: EP  
Altitudinal range: 700-1900 m.

**Name:** *Plagiochila woronofii* St.  
Family: Plagiochilaceae  
Habitat: EP  
Altitudinal range: 700-2000 m.

**Name:** *Porella acutifolia* (Lehm. & Lindenb.) Trevis  
Family: Porellaceae  
Habitat: EP  
Altitudinal range: 900-1700 m.

**Name:** *Porella caespitans* (Stephani) S. Hatt  
Family: Porellaceae  
Habitat: EP  
Altitudinal range: 1100-1600 m.

**Name:** *Porella campylophylla* (Lehm. & Lindenb.) Trevis.  
Family: Porellaceae  
Habitat: EP  
Altitudinal range: 1300-1800 m.

**Name:** *Porella chinensis* (Stephani) S. Hatt.  
Family: Porellaceae  
Habitat: EP  
Altitudinal range: 1100-1800 m.

**Name:** *Porella platyphylla* (L.) Pfeiff.  
Family: Porellaceae  
Habitat: EP  
Altitudinal range: 1100-1800 m.

**Name:** *Radula complanata* (L.) Dumort.  
Family: Radulaceae  
Habitat: NEP, EPH  
Altitudinal range: 900-1900 m.

**Name:** *Reboulia hemispherica* (L.) Raddi  
Family: Aytoniaceae  
Habitat: EP, NEP  
Altitudinal range: 1000-1800 m.

**Name:** *Riccardia multifida* (L.) Gottsche  
Family: Aneuraceae

Habitat: EPH

Altitudinal range: 700-2000 m.

**Name:** *Riccia aravalliensis* Pandé & Udar

Family: Ricciaceae

Habitat: NEP

Altitudinal range: 800-1800 m.

**Name:** *Riccia discolour* Lehm. & Lindenb.

Family: Ricciaceae

Habitat: EPH

Altitudinal range: 700-1900 m.

**Name:** *Riccia warnstorffii* Limpr.

Family: Ricciaceae

Habitat: EP, NEP

Altitudinal range: 700-1900 m.

**Name:** *Scapania verrucosa* Heeg

Family: Scapaniaceae

Habitat: NEP

Altitudinal range: 900-1900 m.

**Name:** *Targionia hypophylla* L.

Family: Targioniaceae

Habitat: NEP

Altitudinal range: 800-1800 m.

**Name:** *Trocholejeunea sandvicensis* Mizut.

Family: Lejeuneaceae

Habitat: EPH

Altitudinal range: 700-1700 m.

**Name:** *Tuzibeanthus chinensis* (Stephani) Mizut.

Family: Lejeuneaceae

Habitat: EP, EPH

Altitudinal range: 700-1700 m.

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