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 montane 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 interaspecific 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 harbour 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° – 50° N to 33° – 30° N longitude and 74° E to 74° – 10° E latitude, covering an area of 2630 km² 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 km². (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.](image-url)
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 sub-tropical vegetation. Common tree elements of this region are, Mallotus philippensis, Wendlandia heynei, Punica granatum, 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.

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 arboreum and Quercus semicarpifolia are also associated with it. The dominant shrubs of this forest type are: Rosa burnonii, Sarcococca saligna, Rutca 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 wallchiana 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 in this forest type are: Ranunculus sceleratus, Rumex hastatus, Rumex nepalensis, Stellaria media, Gnaphalium luteoalbum, Epilobium wallchianum, 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 Peeth
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 affine*, *Potentilla ambigua*, *Primula denticulate*, *Saxifraga flagellaris*, and *Thymus serpyllum* besides shrubby taxa like *Juniperus communis*, *Juniperus recurva Rhododendron anthropogon*, 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 represened 3 species each. Only 2 species each of Cleveaceae and Jungermanniaceae were reported. Aneuraceae, Conocephalaceae, Phaeocerotaceae, Pelliaeceae, Radulaceae, Scapaniaceae and Targioniaceae were represented by single specie 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)

<table>
<thead>
<tr>
<th>Name</th>
<th>Family</th>
<th>Habitat</th>
<th>Altitudinal range</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Asterella angusta</em> (Steph.) Kachroo</td>
<td>Aytoniaceae</td>
<td>EP, NEP</td>
<td>1500-2500m</td>
</tr>
<tr>
<td><em>Asterella blumeana</em> (Nees) Pandé, K.P. Srivast. &amp; Sultan Khan</td>
<td>Aytoniaceae</td>
<td>EP, NEP</td>
<td>1200-2300m</td>
</tr>
<tr>
<td><em>Asterella reticulata</em> (Kashyap) Pandé, K.P. Srivast. &amp; Sultan Khan</td>
<td>Aytoniaceae</td>
<td>EP, NEP</td>
<td>1600-2000m</td>
</tr>
<tr>
<td><em>Athalamia pinguis</em> Falconer</td>
<td>Cleveaceae</td>
<td>EP, NEP</td>
<td>1400-1800m</td>
</tr>
<tr>
<td><em>Athalamia pusilla</em> (Stephani) Kashyap</td>
<td>Cleveaceae</td>
<td>NEP</td>
<td>1400-1800m</td>
</tr>
<tr>
<td><em>Conocephalum conicum</em> (L.) Underw.</td>
<td>Conocephalaceae</td>
<td>EP, NEP</td>
<td>1000-2000m</td>
</tr>
</tbody>
</table>
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 inflate* (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 foreaui* 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
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: Pelliaaceae
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. & Lindemb
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 Lindemb. & 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 Lindemb.
Family: Plagiochilaceae
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 discolor* 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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