# Study on Bryophytes in Sygara Mountain

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**Abstract** In order to identify the species of bryophytes in Sygara Mountain in Tibet, 2390 samples in the area were collected, identified and analyzed. The results show that bryophytes of Sygara Mountain have 26 families, 70 genera and 134 species; among them, 25 families, 69 genera and 133 species are mosses, and only one is liverwort, namely *Conocephalum conicum* (L.) Dum. 4 dominant families are in the descending order of Bryaceae, Dicranaceae, Pottiaceae, Polytrichaceae respectively, and the dominant genera are *Hypnum*, *Brachythecium*, *Plagiomnium*, *Racomitrium* and *Dicranodontium*.

**Key words** Bryophytes, Species, Ecosystem, Sygara Mountain, Tibet

## 1 Introduction

Bryophytes are an informal group consisting of three divisions of non-vascular land plants, the liverworts, hornworts and mosses. They are characteristically limited in size and prefer moist habitats although they can survive in drier environments. The bryophytes consist of about 20000 plant species. Bryophytes have no real differentiation of roots, stems and leaves, and they are relatively small, often with a length of less than 10 cm except for a few species.

In the higher plants, they are the only groups with non-vascular bundles and the gametophyte generation is dominant, and their evolution direction is different from that of vascular plant sporozoites dominant in the life cycle[1]. In nature, bryophytes play the role of pioneers, and are an important part of many vegetation types. They also play a role in promoting the evolutionary process of lakes and forests. Bryophytes are widely distributed, except for the sea and the areas with an altitude of more than 5500 m. In short, the impact of bryophytes on ecological environment as well as vegetation composition and succession can not be ignored[2].

China has vast land area and complex terrain, and there are significant differences in various types of climate. It is one of the countries with the greatest bryophyte diversity. More than 21000 kinds of bryophytes have been reported in the world, of which Musci has 119 families, 854 genera and 12800 species, Hepatucae has 69 families 370 genera and 8000 species, and Anthocerotae has 3 families, 9 genera and about 390 species. The bryophytes recorded in China have 125 families, 572 genera and 3460 species[3], accounting for about 10% of the world's moss species[2]. In addition, the distribution of bryophytes in China is also featured by many endemic species, diverse ecological types and complex floristic elements.

With the rapid economic development, human demand for natural resources is also increasing. In some areas, some environmental problems continue to occur such as deforestation, grassland overgrazing, land desertification and salinization, wetland reduction, water depletion, environmental pollution and greenhouse effects, posing a serious threat to the survival and development of bryophytes, and many unique species significantly decrease. Therefore, the protection of bryophytes diversity should receive much attention[4-5].

In this study, with Tibet's Sygara Mountain as object, we investigated the bryophytes in Tibet, and studied the species composition and characteristics of bryophytes in Sygara Mountain, in order to enrich bryophyte flora in China, and provide a basis for solving the vegetation ecosystem problems facing the development of plateau alpine forest ecosystem.

## 2 Materials and methods

**2.1 Overview of study area** Sygara Mountain (93°12′ - 95°35′ E, 29°10′ - 30°15′ N), on the northwest side of Brahmaputra River in Southeast Tibet, at the intersection of the Nyainqntanglha Mountains and the Himalayas, in Nyingchi County, is the stretching branch of the Nyainqntanglha Mountains from northwest to southeast, forming a wide range of east-west slopes. Most of the areas are 3000 m above sea level or more, the highest peak of Sygara Mountain has an altitude of 5300 m, and the lowest point is in the Parlung Zangbo Canyon, with an altitude of about 2100 m.

Affected by the Indian Ocean monsoon, the climate is featured by warm winters, cool summers, and distinct dry and wet seasons. The average annual rainfall is 1134 mm and the evaporation is 544 mm. The rainy season is from June to September, mainly concentrated in August, accounting for 30% of annual pre-

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cipitation. The annual average temperature is 6.5 ℃, the lowest average temperature is 0 – 2.8 ℃, and the highest average temperature is 11.5 – 18.2 ℃. The frost-free period is 180 d, and the average relative humidity is 60% – 80%. The soil is dominated by mountain brown soil and acidic brown soil.

The main forest vegetation type in Sygara Mountain is mountainous temperate dark coniferous forest, with *Abies georgei* var. *smithii* as constructive species, and there are also *Picea likiangensis* var. *linzhiensis*, spruce-fir mixed forest and *Sabina saltuaria* mixed forest. *Abies georgei* var. *smithii* and *Sabina saltuaria* are the dominant tree species in forest community on shady slope and sunny slope, respectively, and bryophytes are also an important species part of resources under forest.

The bryophytes in Sygara Mountain were not systematically investigated previously, and the quantitative studies of species diversity have not yet been carried out. The study of bryophyte ecology is a process of understanding bryophytes and their growing environment, and provides the necessary reference for mankind to solve the ecological dilemma.

### 2.2 Research methods

**2.2.1** Field investigation methods. 17 10 m × 10 m plots were selected from the shady and sunny slopes with an altitude of 3600 – 4700 m in Sygara Mountain for statistical analysis of trees, shrubs and species, and estimation of crown diameter, tree height and tree crown density. The plot was divided into 2 m × 2 m sample plots.

In each sample plot where there were bryophytes, 50 cm × 50 cm small sample plots were set, the sample frame consisting of 100 5 cm × 5 cm grids was used for sampling, and the number of grid occupied by each kind of bryophyte was recorded as the coverage of a kind of moss in the sample plot[6].

The moss samples in the sample plot were collected and brought back to the laboratory for identification[7-14].

**2.2.2** Data analysis. Excel 2010 and Spss 19.0 are used for statistical analysis and mapping of all the data.

## 3 Results and analysis

**3.1 Overall record of bryophytes in Sygara Mountain** By the detailed investigation from August to October 2015, 2390 moss plant specimens were collected and it was identified that there were a total of 26 families 70 genera and 134 species of bryophytes in Sygara Mountain. The list of bryophytes is shown in Table 1.

In terms of species number, the 4 dominant families are in the order of Bryaceae > Dicranaceae > Pottiaceae > Polytrichaceae. The dominant genera include *Hypnum*, *Brachythecium*, *Brachythecium*, *Plagiomnium*, *Racomitrium*, *Dicranodontium*, *Dicranodontium*. And Bryaceae has 23 species, 17.16% of the total species, there are nine families only having one species, and liverwort has only one species namely *Conocephalum conicum* (L.) Dum.

**3.2 Family composition** For the bryophytes in Sygara Mountain, with the richness of species as a standard, through the statistical analysis of family composition (Table 2), it is found that the major families with more than 10 species are Polytrichaceae, Pottiaceae, Dicranaceae and Bryaceae, accounting for 15.38% of the total families, having 44.03% of the species in the region, and the four families are widely distributed major families, with considerable species.

**Table 1 Overall record of bryophytes in Sygara Mountain**

| Family | Species number | Genus number |
|---|---|---|
| Leucodontaceae | 1 | 1 |
| Leucobryaceae | 1 | 1 |
| Leskeaceae | 1 | 1 |
| Funariaceae | 1 | 1 |
| Entodontaceae | 1 | 1 |
| Amblystegiaceae | 1 | 1 |
| Orthotrichaceae | 1 | 1 |
| Neckeraceae | 1 | 1 |
| Conocephalaceae | 1 | 1 |
| Rhytidiaceae | 2 | 1 |
| Sphagnaceae | 2 | 1 |
| Brtramiaceae | 2 | 1 |
| Ditrichaceae | 3 | 1 |
| Splachnaceae | 3 | 2 |
| Sematophyllaceae | 4 | 2 |
| Hylocomiaceae | 4 | 3 |
| Thuidiaceae | 4 | 4 |
| Plagiotheciaceae | 6 | 1 |
| Mniaceae | 9 | 3 |
| Brachytheciaceae | 9 | 4 |
| Grimmiaceae | 9 | 5 |
| Hypanaceae | 9 | 8 |
| Polytrichaceae | 10 | 3 |
| Pottiaceae | 11 | 8 |
| Dicranaceae | 15 | 10 |
| Bryaceae | 23 | 4 |

Most species have a strong ability to adapt to the environment, and Pottiaceae is distributed in the temperate zone. The families having nine species include Hypnaceae, Brachytheciaceae, Mniaceae and Grimmiaceae, accounting for 15.38% of total families, having 26.86% of species in the region.

In addition, Plagiotheciaceae has six species, and Sematophyllaceae, Hylocomiaceae and Thuidiaceae have four species, respectively, indicating that the distribution of these widely distributed species have a certain relationship with the altitude, temperature and humidity; each of the remaining 14 families only has 1 – 3 species, and only 1 – 2 species exist in a large number of families, indicating the complexity of bryophyte family and genus composition in the region.

The families and genera having only one species, show the distribution and migration process of bryophyte family and genus in the region in two opposite directions. The species belonging to the newly distributed families and genera have been not yet rich, with no arrival of new species.

The species belonging to the obsolete families and genera

which are not adapted to this environment, ta large number of species have disappeared in the region, and the existing species are only the occasional species distributed in the microhabitat[15].

**Table 2 The bryophyte family composition in Sygara Mountain**

| The number of species | The number of families | The name of families | Share in the total families in the area//% |
|---|---|---|---|
| 1 | 9 | Leucodontaceae | 34.62 |
| | | Leucobryaceae | |
| | | Leskeaceae | |
| | | Funariaceae | |
| | | Entodontaceae | |
| | | Amblystegiaceae | |
| | | Orthotrichaceae | |
| | | Neckeraceae | |
| | | Conocephalaceae | |
| 3 | 3 | Rhytidiaceae | 11.54 |
| | | Sphagnaceae | |
| | | Brtramiaceae | |
| 3 | 2 | Splachnaceae | 7.69 |
| | | Ditrichaceae | |
| 4 | 3 | Sematophyllaceae | 11.54 |
| | | Hylocomiaceae | |
| | | Thuidiaceae | |
| 6 | 1 | Plagiotheciaceae | 3.85 |
| 9 | 4 | Hypanaceae | 15.38 |
| | | Brachytheciaceae | |
| | | Mniaceae | |
| | | Grimmiaceae | |
| 10 | 1 | Polytrichaceae | 3.85 |
| 11 | 1 | Pottiaceae | 3.85 |
| 15 | 1 | Dicranaceae | 3.85 |
| 23 | 1 | Bryaceae | 3.85 |

**3.3 Genus composition** According to the number of species belonging to 70 genera of bryophytes in Sygara Mountain (Table 3), it shows that *Plagiothecium* only having a genus has six species; *Bryum* has 23 species, and becomes the dominant species in the region, indicating that this genus is highly tolerant of the unique plateau alpine climatic types, and it can be seen that the dominant species in the region are not obvious, indicating that the unique climatic types have strong selectivity to bryophytes.

There are nine genera containing only one species, showing that the genera containing only one species have not many advantages. For the dominant genera of bryophytes in Sygara Mountain, the genus distributed in the temperate zone is *Brachythecium*, and the widely distributed genus is *Bryum*.

From the above analysis, it is found that the floristic elements of bryophytes in Sygara Mountain are dominated by the temperate elements but there are also some tropical elements. Thus, in terms of dominant family and genus level, the bryophytes in the region are in the transition zone from temperate zone to tropical zone.

**Tables 3 Genus composition of bryophytes in Sygara Mountain**

| The number of species | The number of genera | Share in the total genera in the area//% |
|---|---|---|
| 1 | 9 | 12.86 |
| 2 | 3 | 4.29 |
| 3 | 3 | 4.29 |
| 4 | 9 | 12.86 |
| 6 | 1 | 1.43 |
| 9 | 20 | 28.57 |
| 10 | 3 | 4.29 |
| 11 | 8 | 11.43 |
| 15 | 10 | 14.29 |
| 23 | 4 | 5.71 |

## 4 Conclusions

Through the investigation of bryophytes resources in Sygara Mountain, there are not many bryophyte species in the region, a total of 26 families and 70 genera and 134 species, of which there is one kind of liverwort namely *Conocephalum conicum* (L.) Dum. This may be related to the region's unique climate and high altitude environmental factors.

At the same time, the perennial rain, lack of light, rock-based matrix and other factors in the specimen collection area have caused only a few liverwort plants to survive and reproduce. The bryophyte community in Sygara Mountain is mainly composed of clustered green, brownish green and yellowish green mosses, with dense leaves and large water stock.

Compared with the typical mountain types in the mainland, the diversity of bryophytes in Sygara Mountain is related to the unique Tibetan climate types. By the statistical analysis of mosses in Sygara Mountain, it is found that the major families with more than 10 species are Polytrichaceae, Pottiaceae, Dicranaceae and Bryaceae, accounting for 15.38% of the total families, having 44.03% of the species in the region, and the four families are widely distributed major families, with considerable species.

The families having nine species include Hypnaceae, Brachytheciaceae, Mniaceae and Grimmiaceae, accounting for 15.38% of total families, having 26.86% of species in the region. In addition, Plagiotheciaceae has six species, Sematophyllaceae, Hylocomiaceae and Thuidiaceae each have four species. These families are all widely distributed in the world, placing not high demand on the growth environment, while the other families mostly have monotypic genera.

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**6.2 Recommendations** In the first place, it is necessary to strengthen the scientific research of genetically modified organisms, and solve the mystery of genetically modified food as soon as possible to reduce or even solve the controversy of genetically modified food.

In the second place, it is necessary to carry out the science and education publicity about genetically modified food for the college students.

Finally, when the consumers use the heuristic information processing mode, the market should release a more positive signal to reduce the perceived risk of consumers.

The government departments, a variety of traditional media and new media should also play their role to more fairly and objectively report and publicize.

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