Taxonomic studies and the distributional analysis of the Bryopsida (Bryophyta), from the Western Himalayas, Pakistan.

Introduction

Pakistan is thought to have recent origin, which lies between 23°- 37°N and 61°- 81°E with an absolute territory of 804,152 square km (Ali and Qaiser, 1986). Pakistan is expended from Arabian Sea (in the West) toward the top mountains of Asia. Geographically Pakistan is consisting of three major regions: a) Northern mountainous region b) Region of Baluchistan plateau, and c) Region of Sindh and Punjab plains. The estimated recorded rainfall is between 75 mm to 1,650 mm per annum. Pakistan contains four provinces: Punjab, Sindh, Baluchistan and North-West Frontier Province, including other two regions, Azad Kashmir and Baltistan (Higuchi and Nishimura, 2003).The humid hilly regions i.e. Murree, Kashmir, Swat, Dir and Hazara have rains in all the season, and dominating summer rain fall. While the arid mountain zones including Waziristan, Quetta, Khyber, Gilgit, Chitral, Upper Dir, and Khagan Kishenganga have rainfall usually during spring and winter months. As Pakistan covers a significant area from North-South, so there is a huge diversity of temperature and Topography (Ali and Qaiser, 1986).

The Himalayas is an Asian mountainous region which separates the Indian subcontinent from Tibetan Plateau. It also includes the Hindu Kush, the Kara Koram range, and some other ranges. Himalayas is the earths highest mountains system and it is home to the highest mountains including the Mount Everest and K-2. The Himalaya range extends from west to east, from the valley of Indus river to Brahmaputra valley. In width it stretches from the Xingiang-Kashmir region to the Arunachal Pradesh Tibet region (Abbasi et al., 2011). The north-western part of Pakistan contains three major mountain ranges of the world i.e. Hindu Kush, Karakoram and Himalayan, which together imparts more phytogeographical values and variety of floral vegetation. Humidity and higher rainfall in Eastern Himalayas dominate the monsoon-driven vegetation. Generally, the vegetation of Western Himalayas shows more affinities with the flora of Hindukush range which have cooler and a dried climate. The diversity in the Himalayan vegetation includes evergreen species of the tropical region native to south-east to the north-western regions containing alpine species (Khan et al., 2012). Himalayas shares one of the most unusual and richest ecosystem on the globe. Himalayan alpine communities keep extraordinary ecological significance by maintaining the functioning of ecosystem, by keeping the soil firm to the catchment sites, and have ethical, cultural and aesthetic values (Shaheen et al., 2011).

With more than 12,000 species reported around the world, Bryophyta (mosses) is the most important phyla among the bryophytes, while remaining two phyla are Marchantiophyta (liverworts) and Anthocerotophyta (hornworts). The “bryophytes” is a broad term used for these three phyla because of their superficial resemblance. Bryophyta inhabit a wide variety of habitats, from pole to pole. Life cycle of mosses have dominant gametophyte like hornworts and liverworts. Gametophytic generation is persistent haploid photosynthetic phase. The sporophyte is matrotrophe which is completely attached to the gametophyte for nourishment. Mosses possess small gametophyte, and are perennial plants having unbranched or branched system of shoots along with leaves in spiral arrangements. Mosses inhibit in the form of colonies and populations such as cushions, wefts, mats and hardly present as a single separated individual. Though mosses possess uniform features regarding life history but exhibit complex anatomical as well as morphological differences in both sporophyte and gametophyte organization (Crandall-Stotler and BartholomewBegan, 2007).

Mosses are generally ranked into five super classes on the basis of morphology i) Superclass I: consist of only Takakia ii) Superclass II: for Ambuchanania, sphagnum and Seppelt & H. A. Crum iii) Superclass III: with Andreaea and Acroschisma Lindley iv)

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Superclass IV: consist of only Andreaeobryum v) Superclass V: entirely of peristomate mosses (having major diversity among mosses) (Crandall-Stotler and Bartholomew-Began, 2007). The second biggest lineage of land plants is formed by mosses. Mosses show ecological and morphological diversity by containing about 12,800 species. Preliminary all three bryophytic groups (liverworts, hornworts and mosses) considered as classes of bryophyte division. However, molecular analysis confirmed the bryophytes as paraphylates , along correlation of liverworts and other existing land species being sisters and while, mosses sister to clade of vascular plants and hornworts. So, it confirmed that the independent lineage position of all three bryophytic groups in the evolution of land plants, and now they are widely accepted as separate divisions, Marchantiophyta (liverworts), Anthocerotophyta (hornworts) and Bryophyta (mosses). Beside other two groups of bryophytes, mosses are hardely characterized on the basis of anatomical-morphological synapomorphies. However, molecular level characterization has well confined the all bryophytic lineages (Stech and Frey, 2008).

Class Bryopsida are true mosses they also contain acrocarpous (so-called mosses) which are mostly sparsely branched and have terminal archegonia. On the other hand, Pleurocarpous mosses have extensive branches and produce lateral archegonia. While, the Cladocarpous taxa have intermediate features by containing terminal archegonia with lateral branch system. Pleurocarpous mosses comprise two orders, Hypnales and Hookeriales, and they create acrocarpous or cladocarpous derived monophyletic group (Vanderpoorten et al., 2002).

The moss Flora of the Pakistan is still poorly known. It requires huge efforts to report all the species. Few bryologists have worked with the moss Flora of Pakistan but these efforts were made by the foreign bryologists. Currently there is not any single resident Bryologist in the country dealing with the moss Flora of Pakistan. The mosses of southwestem (Balochistan and Sindh) and southern areas of Pakistan are still not explored. In Pakistan, the previous studies about the moss Flora are found sparsely; even the researchers have to consult back till the end of nineteenth century. The moss Flora of Pakistan has been revised by Higuchi and Nishimura, according to which it comprises of 356 taxa, 324 species and 32 intraspecific taxa, including 124 genera with 33 families (Higuchi and Nishimura, 2003) (Gruber and Peer, 2010).

Background Justification of the Research Project

Himalayas is a very rich region as far as its Biodiversity is concerned. Various studies have been conducted on the Floral diversity of the Himalayas including Angiosperms, Gymnosperms and Pteridophytes, but as far as the Bryophytes are concerned, the studies which are carried out are very less. The Class Bryopsida is the largest class of Phylum Bryophyta. The class is very diverse in nature and adopted various habitats of the world. The moss Flora of Pakistan is not updated from several years, and in Pakistan, almost all the families of this class are just being reported in different checklists, hence there is a lack of knowledge about their detailed morphology. The previous studies mostly include the reporting of different species from different areas. That is why class Bryopsida requires further study in macro and micromorphology from this particular region. The main purpose of the present research work is to further elaborate the morphological characters of Bryopsida and to update the moss Flora of Pakistan. In the current proposed research project, different families of Bryopsida will be collected from different areas of Pakistan, and detail macro and micromorphological features will be discussed along with their habitat and distribution.

Objectives of the Study

1)Preparation of an updated checklist of the moss Flora of Pakistan. 2)Comparative use of Light and Scanning electron microscope to investigate the selected families of

Bryopsida. 3)Use of light microscope to study the detailed morphology of the species. 4) Application of Scanning electron microscope (SEM) to study and discuss the micromorphological characters of the gametophyte (mainly leaf surface). 5) Study of both qualitative and quantitative characters of the gametophyte and sporophyte. 6) Deposition of the voucher specimens at the Herbarium of Pakistan Museum of Natural History (P.M.N.H) and the Herbarium of University of Malaya.

Materials and Methods

The field surveys and collection will be made from the specified study areas of the Western Himalayas, Pakistan. Fresh specimens will be collected in the form of mats or tufts. Field data including exact locality, habitat, date of collection and collectors name will be recorded. Specific voucher number will be given to the specimens for example A.S.K-25. For identification and comparison of collected species, the studied species will be compared with the Bryophyte collection of Japanese researchers, held at the cryptogamic lab of Botanical division of Pakistan Museum of Natural History. The identification of species will be carried out by studying the morphological and anatomical characters. Identification will also be aided by comparing with the distinguishing characters discussed in the moss Flora of Japan, China and Flora of North America. For the confirmation of species, specialist bryologists of specific families will also be consulted. For the preservation of moss species, the air-dried specimens will be kept in simple but good quality paper bags for future study. For the study of morphological characters, stereoscope and light microscope will be used. Four to seven specimens per species will be utilized for morphological characters. Qualitative and quantitative characters will be studied. To investigate the micromorphology, air dried samples will be used for Scanning Electron Microscope (SEM) will be used.

References

Abbasi, A. M., Khan, M. A., Ahmad, M., & Zafar, M. (2011). Medicinal plant biodiversity of lesser Himalayas-Pakistan. Springer Science & Business Media.

Ali, S.I., Qaiser, M., 1986. A phytogeographical analysis of the phanerogams of Pakistan and Kashmir. Proc R Soc Edin [Biol] 89, 89-101.

Crandall-Stotler, B.J., Bartholomew-Began, S.E., 2007. Morphology of mosses (phylum Bryophyta). Fl. N. Amer. Mexico 27, 3-13.

Gruber, J.P., Peer, T., 2010. A contribution to the knowledge of the bryophyte flora of the mountains of North Pakistan (Autonomous Region of Gilgit-Baltistan). Herzogia 25(2), 271-286.

Higuchi, M., Nishimura, N., 2003. Mosses of Pakistan. J. Hattori bot. Lab. 93, 273- 291.

Khan, S.M., Page, S., Ahmad, H., Shaheen, H., Harper, D., 2012. Vegetation dynamics in the Western Himalayas, diversity indices and climate change. Sci., Tech.and Dev 31(3), 232-243.

Shaheen, H., Khan, S.M., Harper, D.M., Ullah, Z., Qureshi, R.A., 2011. Species diversity, community structure, and distribution patterns in western Himalayan alpine pastures of Kashmir, Pakistan. Mt Res Dev. 31(2), 153- 160.

Stech, M., Frey, W., 2008. A morpho-molecular classification of the mosses (Bryophyta). Nova hedwigia 86(1-2), 1-21.

Vanderpoorten, A., Hedenäs, L., Cox, C.J., Shaw, A.J., 2002. Phylogeny and morphological evolution of the Amblystegiaceae (Bryopsida). Mol Phylogenet Evol 23(1), 1-21.