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A REVIEW ON DISTRIBUTION AND USES OF PLANT AMPHIBIANS: BRYOPHYTES

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ABSTRACT

Bryophytes composed of three main divisions of non-vascular land plants, liverworts, hornworts and mosses consists more than 23,000 plant species. They preferably grow on moist habitats and are smaller in size. They require abundant water and soil for their successful growth hence referred as Plant amphibians. They found widely distributed in hilly regions and plains depending upon the favorable atmospheric conditions. Most of the bryophytes are autotrophic but some of them show epiphytic, epiphyllous, saprophytic nature. Bryophytes show a morphological and reproductive diversity and do not produce flower or seeds. Instead they produce gamma, tiny buds, disc, etc for their multiplication. Bryophytes are secondary colonizers after lichens due to their ectohydric nature and can remain survive at acute adverse conditions. Bryophytes can be multiplied through their minute but resistant spore. These are medicinally, ecologically, ethnobotanically and economically important plant group widely utilized worldwide for different purposes. An account of their distribution, Phytochemistry, Medicinal, ecological, ethnobotanical and economic prospects is attempted here.

KEY WORD- Bryophytes, Plant Amphibians, Distribution, Ethnobotanical, Economic Importance

INTRODUCTION

Bryophytes are the higher cryptogamic primitive plants found distributed throughout the world. Due to their diversity and cosmopolitan nature, they are considered as the second largest plants after the dominant flowering plants. They can grow on a wide range of substrata including rotten wood, bark of higher plants, soil, roofs, mud walls, leaves of green plants, rocks and stones. They are considered as secondary colonizers on barren rocks after lichens. They are distinct group of plants morphologically and anatomically. Although, they do not develop true roots, stem and leaves, they have such structures to meet needs like anchorage, water absorption,

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support and photosynthesis. Bryophytes can be studied under three different classes' viz. Hepaticopsida (Liverworts), Anthocerotopsida (Hornworts) and Bryopsida (Mosses). Mosses are the largest and more diverse group constitutes about 10,000 to 15,000 species followed by liverworts having estimated 6,000 to 8,000 species. Hornwort is a smallest class of bryophytes which composes approximately 100 species. Most of the bryophyte species are small in size ans some can attain height more than half meter. They have the ability to stodre large amount of water, nutrients and carbon in their biomass. They can absorb water, inorganic nutrients and mineral elements directly from atmosphere due to their ectohydric nature of metabolism (Bahuguna et.al. 2013). Bryophytes are very important plants for the purpose of regulation of ecosystem, medicine, horticulture, for seed beds, pollution indicators etc.

DISTRIBUTION

Bryophyte are successfully grows in constantly changing terrestrial environment due to their smaller size and poikilohydric strategy for water and nutrients. They can remain alive after acute dehydration which is referred to as desiccation tolerance. They can maintain efficient photosynthesis under low light conditions and have low chl a/b ratio. Bryophytes have relatively low optimal temperature for growth. They with their small and resistant spores are able to disperse over long distances by wind, which might help their survival in a changing environment (Marschall, 2017).

Hot spots are places with high bryophyte diversity which have different substrate and habitat conditions. New Zealand, New Caledonia, The Pacific Islands and Indonesian part of eastern Malaysia are world's hot spots of bryophytes (Hallingback and Tan, 2010). Bryophytes are distributed in tropical, subtropical and temperate regions of world. More than 23000 species of bryophytes found distributed and recorded throughout the world which make them largest plant group after flowering plants. Bryophytes are able to grow in extreme conditions and are the major components in Arctic, Antarctic and Alpine environment. India constitutes 2850 bryophyte taxa. (Bahuguna et.al. 2013). According to Dandotiya et. al, (2011), 2489 taxa of bryophytes are recorded in India which includes 1786 species of mosses, 675 species of liverworts and 25 species of hornworts. Most dominate genera are of all three categories are *Fissidens, Barbula, Campylopus, Riccia, Porella, Frullania Jungermannia, Anthodceros* etc. 340 taxa of bryophytes are recorded to be endemic including 269 species of mosses, 67 species of

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liverworts and 4 species of hornworts. Abundant species of bryophytes occurs in Himalaya, Eastern Ghats and Western Ghats. Rao and Rao (2013), carried out a study on diversity and distribution of bryophyte species in Eastern Ghats by using quadrate method found 10 species grown belonging to six families. *Funaria hygrometrica, Marchantia polymorpha, Plagiochasma rupestre, Plagiochasma wrightii, Polytrichum alpinum, Polytrichum densiflorum, Riccia discolor, Riccia fluitans, Sphagnum cymbifolium, Sphagnum squarrosum* are the bryophyte species found distributed in the G. Madgula forest region of Eastern Ghats of India. *Polytrichum densiflorum* is the most frequently recorded species in the region.

9 species of bryophytes have been recorded in Huzurabad division of Telangana (Odelu, 2015) including *Funaria hygrometrica, F. Leptopoda, Polytrichum alpinum, P.densiflorum, Riccia discolor, R. fluitans, R.sorocarpa, Sphagnum sp. and Tortula ruralis Philonotis sp., Rhodobryum giganteum, Fissidens nobilis, Plagiomnium sp., Mniuum sp., Dawsonia superb, Pongatum macrophyllum,Polytrichum sp.,Barbula sp., Sphagnum cericeum,Riccardia sp., Herbertus sp., Dumortiera sp., Marchantia sp., Pallavicinia sp., Plagiochila sp.,*are the common bryophytes species found distributed in Mt. Kalatungan and Kitanglad natural parks of Philippines (Andrea et. al, 2011). In the central Province of Sri Lanka researchers could record total 56 species of bryophytes belonging to groups, liverworts, mosses and hornworts. *Plagioschasma rupestre, Cyathodium foetidissimum, Dumortiera hirsuta,Lunularia cruciata, Marchantia amboinensis, Jungermannia obovata, Myurium rufescens, Plagiothecium latebricola, Pongatum aloides* etc are some of the common bryophytes recorded in by them (Ruklani and Rubasinghe,2013).

Pharo and Beattie (1997) recorded 77 different species of bryophytes from a region of Australia whereas 105 bryophyte species including 64 liverworts and 41 mosses have been reported from Terceira forests of Azores (Gabriel and Bates, 2005). *Plagiochila bifaria, Frullania tamarisci, Lejeunea lamacerina, Diplophyllum albicans, Scapania gracilis, Hypnum uncinulatum,Thuidium tamariscinum* are some of the common species reported from the region.(Gabriel and Bates, 2005).

Higuchi M. (2011), reviewed a total 165 taxa of bryophytes which are endemic to Japan. Only the moss and liverwort species are endemic to Japan and none of hornworts. *Taxiphyllopis* and *Yakushimabyum* of mosses and *Cavicularia* and *Hattoria* of liverworts are endemic to Japan

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and monospecific. Total 212 taxa are recorded in Zackenberg valley of northeast Greenland which composes 43 liverworts and 169 mosses (Hassel et. al., 2014).

Bryophyte flora of Czech Republic analyzed and updated with 863 species of bryophytes including 652 mosses, 207 liverworts and 4 hornwort species. Flora is also supplemented with 5 additional subspecies, 23 varieties and 17 other species with uncertain occurrence. It is claimed that 46 % of above all are qualified for inclusion on Red list categories (Kucera et.al, 2012).

PHYTOCHEMISTRY OF BRYOPHYTES

Biochemical information of bryophytes provides information about their relationship among themselves as well as with other plant groups. Bryophytes contains variety of phytochemicals compounds like terpenoids, carbohydrates, hormones lipids, proteins, steroids, polyphenols, organic acids, steroids, sugar alcohols, fatty acids, aliphatic compounds, aromatic compounds and so many others (Ogwu,2019). It is evident that bryophytes are not infested by beetles as they contain natural pesticides. Liverwort *Plagiochila* contains sesquiterpene hemiacetyl plagiochiline A, which can be used as a potent poison for African Army worm and are with great taxonomic value. About 65 types of sesquiterpenoids are reported in liverworts.In plants like *Bazzania*, *Porella* and *Scapania*, the sesqiterpenoids like drimenol, cuprane have been recorded. Diterpenoiides are restricted to liverworts only and 18 diterpenoids like labdanes, kauranes are reported. They also contains flavonoids like apigenin, acacetin, leeoi, scoparin etc. (Bahuguna et.al, 2013).

The species *Brachythecium rutabulum* and *Mnium hornum* is reported to contain m- or p-coumaric acid which serves as antifeedants for sluges. It is also reported that, *Isotachis japonica* contains different aromatic esters like benzyl benzoate, benzyl cinnamate and B- Phenylethyl cinnamte and other compounds unique odour in plant. (Glime, 2007). Bryophytes contain different types of polysaccharides which play an important role in stress tolerance, evolution of chemical diversity and structural and functional material. It is reported that, Sphagnum moss contains different types of polysaccharides including D-galacturonic acid, glycuronoglycan, L-rhamnose and D-galactose. Cell wall of bryophytes is made up of cellulose, hemicelluloses and pectin like polysaccharides (Klavina, 2015).

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MEDICINAL USES

The bryophytes are long been used in herbal medicines of India and China. *Marchantia polymorpha* is used for the treatment of liver ailments, pulmonary tuberculosis and inflammation. *Plagiochasma appendiculata and Riccia sp.* are used on skin diseases including ringworms, Polytrichum sp. is used to heal wounds (Shirsat, 2008, Thieret, 1956). It is noted that, many bryophytes species are highly applicable as a medicine on various types of ailments in Philippines. *Riccia fluitans* is used to inhibit bacterial growth. (Andrea et. al, 2011, Glime, 2007). They are applicable for healing burns, as an antipyretic and antidotal (*Philonotis sp*), cardiovascular problems, nervous prostration, anti-hypoxia, antipyretic and diuretic (*Rhodobryum giganteum*). *Fissidens nobilis and Dawsonia superba* are used as a hair growth stimulator and can be used as a tonic. It is also recommended for various bacterial infections. *Plagiomnium sp., Polytrichum sp. are* used as poultice to reduce pain of burns, bruises and wounds. *Philonotis, Bryum* and *Mnium* also used for same propose (Saxena and Harinder, 2004). *Riccardia* sp. *and Plagiochila sp. are* useful for the treatment of leukemia and also used as poultice to set broken bones.

Chandra et.al (2016) enumerated 50 different bryophytes which are used remedy for many ailments among tribal people of different parts of world. It is evident that, tribal communities in Africa, America, Europe, Poland, Argentina. Australia, New Zealand, Turkesy, Japan, Taiwan, Pakistan, China, Nepal and India are depending upon different bryophytes to cure their normal and severe ailments like cancer. The species like *Frullania hygrometrica, Reboulia hemisphaerica, Conocephalum conicum, Marchantia polymorpha, Polytrichum commune* are used to cure various hepatic disorders. *Sphagnum teres* is used to cure various eye diseases in china. Other *Sphagnum* species is used in surgical dressing as it has better absorption capacity. *Polytrichum commune* is very useful in cancer therapy. It is especially used for lymphocytic leukemia. Other species like *Marchantia palacea, M. polymorpha, Riccardia multifida* etc are applicable for other types of cancers. *M. polymorpha* is also used in India for boils and abscesses (Saxena and Harinder, 2004). Liverworts like *Atrichum, Dicranum, Minium* and *Polytrichum* are antibiotic in nature.

ECOLOGICAL USES

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Bryophytes play very crucial role in natural ecosystem and are essential for the sustainability of human civilization. These are also important in water recycling, biomass production and carbon and nitrogen fixation (Hallingback and Tan, 2010).The species *Pogonatum macrophyllum* and *Rhodobryum giganteum* are used to check soil erosion (Andrea et. al, 2011). Bryophytes have an ability to collect water to conduct their internal processes and useful for other members of the ecological community in respect to nutrient cycling, water retention, water availability and community maintenance. This process is referred as 'Buffer system'. The water storage capacity of bryophytes is influenced by changes in altitudinal gradients and reported to be more in sub-alpine regions (Oishi, 2018). The ecological and reproductive strategies of bryophytes are reflected by environmental variability. This indicates their sensitivity towards the changing environmental conditions. Factors like vertical gradient of light, humidity, wind speed influence the ecophysiology of bryophytes (Ogwu, 2019). Bryophytes are able to provide moisture, appropriate temperature, organic matter and minerals after death, they play very crucial role in the maintenance and replenishment of forest cover (Saxena and Harinder, 2004).

Liverworts and mosses are often excellent indicators of environmental conditions. Sphagnum is an actual indicator of acid, poor soil condition, low and high level of nitrogen. *Ceratodon purpureus, Sphagnum, Funaria hygrometrica, Psilopilum laevigatum* etc are come indicators in environment. The species like *Jungermannia vulcanicola* and *Polytrichum* Sp. are also used as a source for bioremediation for the metals like iron. Likewise different species of bryophytes are useful for the control of soil erosion and, soil conditioning, nitrogen fixation, Study of different types of pollutions, aquatic bioindicators and in waste treatment (Glime, 2007).

The feature like habitat diversity, structural simplicity, totipotency, rapid rate of multiplication and high metal accumulation capacity make bryophytes a role model for pollution studies. Their remarkable decline and absence in forests where they were once abundant is the indication of increased air pollution. Air pollutants may be release in the form of Carbon monoxide, Fluorides, hydrocarbons, hydrogen sulphide, nitrogen oxide, ozone, sulphur dioxide, ammonia and they are highly phytotoxic cause's depletion of bryophytes. Mosses like *Bryum, Ceratodon, Dicranoweisia, Funaria Hyophyila* and *torula* are supposed to be tolerant to the increased air pollution (Bahuguna et.al. 2013). Species like *Sphagnum, Jungemannia*

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vulcanicola, Scapania undulate, Funaria get differently affected by the air pollution. Many bryophyte species like *Dicranum scoparium, Conocephalum conicum, Marchantia polymorpha, Grimmia laevigata, Hedwigia ciliata, Polytrichum commune and Mielichhoferia* proved to be effective accumulators of metals such as Mercury, Bimetals, tin, silver, copper, lead and boron. Due to their abilities they are also treated as biomonitoring agents (Govindapyari et.al, 2010).

Bryophytes act as excellent indicators of different types of contaminants in terrestrial and aquatic habitats. Mosses are able to accumulate a wide range of heavy metals like Pb, Co, Cr, Cu, Cd, Mo, Fe, Ni, V, Sb, Zn A etc., radionuclide's and toxic organic compounds. The total metal binding capacity is determined by the number of available exchange sites and morphological structures of the bryophytes which is different in different species (Zechmeister et.al. 2003). Bryophytes cover the floor of temperate rainforests influences a number of important ecosystem processes like carbon cycling. Mosses such as *Achlorophyllum quadifarium, Dicranoloma billardierei, Hypendendron comatume, Ptycomnion aciculare* etc and Liverworts such as *Bazzania novae-zelandiae, Heteroscyphus coalitis, Leiomitra lanata, Riccardia crassa* etc are some common species which contribute in carbon exchange by the formation of diverse forest floors. It is also reported that, water and carbon dynamics of bryophytes canopies can be affected by the degree of their capillary integration. The capillary integration mechanism may be the important characteristic in bryophyte canopies (Rice,2012).

As compare to vascular plants bryophytes have great ability to retain some minerals in their substrata. So, in geobotanical studies they are very important to know the mineral sites before mining. Species like, *Barbula, Gymnocolea, Merceya Solenostoma* etc are preferred to grow in high copper, zinc, iron and lead containing sites. Such a other species like *Campylopus* are known to grow on gypsum (Bahuguna et.al, 2013)

ETHNOBOTANICAL AND OTHER USES

Bryophytes are utilized for different purposes including economic and medicine throughout the world. *Sphagnum* commonly known as peat moss is commonly used as storage material as it has special cells to store water and it is also recommended for Phytoremediation (removal of toxic contents). *Sphagnum cymbifolium* is highly applicable in nursery for transport of plants without desiccation. It is also recommended for production of methane and can be served as a source of biofuel. The people from Himalayan region use to dry mosses and

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liverworts in to coarse powder and sprinkle over grains to repel different types of pest. (Rao and Rao, 2013, Saxena and Harinder, 2004, Glime, 2007). Bryophytes plays very important role in horticulture, industry, fuel, house construction and preparation of many household equipments. In horticulture they are used as soil additives, ornamental material for cultivation and in Japanese gardens. Their horticultural utilization is mainly due to high water holding capacity and permeability to air. Commonly used bryophytes in horticulture are *Sphagnum* Sp., *Polytrichum commune, Leucobryum neilgherrence and Bartramia pomiformis* (Glime, 2007). Peat mosses are used for the production of methane and heat which can be utilized for the production of electricity in future. They also have ability of preservation and can be used for the preservation of dead bodies (Gunathilaka, 2019).

Liverworts and mosses have been used in Finland, Sweden, Ireland, Germany and Poland for the purpose of fuel. In some Himalayan regions where there are scarcities of woody plants, mosses like *Sphagnum* are used as construction material for house. Mosses like *Climacium japonicum* are used in Japan, England, France, Finland and America are used to make ornamental products like dry flowers. In India, mosses are used as an insulator and also used to make bedding, mattresses, cushions and pillows etc. In India, the bryophyte species like *Sphagnum, Hypnum cupressiforme, Macrothamnium submacrocarpum, Neckera crenulata* etc are used to pack apples and plums (Saxena and Harinder, 2004). It is also reported that, local people different parts of world, use different types of bryophytes for many ethnobotanical purposes. For instance, the species *Philonotis* and *Herbertus* sp*are* used by local shepherds for chinking in temporary homes (Andrea et. al, 2011).

It is reported that some bryophyte species including *Riccia gangetica, Homalia trichomonoides, Dumortiera hirsute, Sphagnum portarecense, Plagiochasma articulatum, Anthoceros longii* etc are having antifungal and antibacterial properties against pathogens like *Curvularia lunata, Candida albicans, Agrobacterium tumifacians* etc (Deora and Suhalka, 2017).

CONCLUSION

In the present article, author tried to assemble information about the distribution bryophytes along with ethnobotanical, ecological medicinal, economic and other uses of bryophytes. It is clear that bryophytes plays very crucial role in environment for regulation of nutrient cycles as well as other atmospheric cycles. They are also plays an important role as indicators and monitoring of pollution in the environment. Some bryophytes are useful sources

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for bioremediation of contaminated soils and water by various metals and pollutants. Apart from their ecological prospects, bryophytes are used worldwide as a medicine for the treatment of common to severe elements. Different communities throughout the world use bryophytes ethnobotanically and for economic purposes. By considering their wide spectrum of applications, it is needed to conserve them and should be protected from various manmade and natural calamities.

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