

A Short Review of the Ethno-Medicinal Perspectives of Bryophytes

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ABSTRACT

Bryophytes are one of the largest and ancient non-vascular plant groups that include the liverworts (Marchantiophyta), hornworts (Anthocerotophyta) and mosses (Bryophyta). They are a rich source of sugar alcohols, aliphatic and aromatic compounds, prenylquinones, phenolics and other secondary metabolites, many of which exhibit extraordinary range of bioactivities and medicinal properties. Several evidences have been reported on the use of bryophytes as herbal medicine by the native inhabitants of China, India and native Americans since the ancient time. Ethno-bryology is now receiving much attention as there is hardly little documented information. This brief review summarises the available reports on the uses of Liverworts and mosses as ethno-medicine by Indian tribal communities such as Adivasi Oriya, Adivasi Telegu, Irula, Muduga, Gaddi, Khamti, Kani and other tribal communities from Himalayan and Melghat Forest region, as well as from several other countries. Common ethno-medicinally utilized Liverworts are *Riccia*, *Marchantia*, *Plagiochasma*, *Targionia*, *Riccardia*, *Dumortiera*, *Reboulia*. Mosses like *Polytrichum*, *Sphagnum*, *Bryum*, *Pogonatum*, *Rhodobryum*, *Entodon*, *Fissidens*, etc., are also popular sources of ethnomedicines.

Key Words: Ethnobryology; Tribal Communities; Liverworts; Mosses; Ethnobotany; Ethnomedicine .

INTRODUCTION

Nature is a treasure box for human beings and plant kingdom is the most precious part of it. Since time immemorial, we are completely dependent on plants in various aspects such as food, shelter, medicine etc. Early humans gradually developed knowledge about natural medicines sorting out novel methodologies for crude development of new drugs. Such forms of natural medicine are mentioned in the traditional Ayurveda, ancient Chinese and Korean Medicines etc. Study of Traditional medicine gained a lot of attention by the researchers in these days because natural products are the most affordable, simple and side effect less source of medicine (Halder and Chakraborty 2018). A new branch of study, popularly known as Ethnobotany, deals with the study of tribal people and utilization of different plants in their daily life as medicine, food, fodder, and

for other economic and traditional purposes. The term Ethnobryology was first introduced by Seville Flowers for the usage of bryophytes by Gosiute People in Utah (Flowers 1957). Ethnobryology, the study of bryophytes which are utilised by the different group of indigenous people, is now gaining much attention as the field still remains unexplored.

Bryophytes are one of the largest non-vascular plant groups. The total number of bryophytes is estimated to be about 14,000 to 15,000 species, of which about 6,000 are liverworts, 200 are hornworts and approximately 8,000 are mosses (Hallingback and Hodgetts 2000). In India, 2,489 species of bryophytes was reported, among which 1786 species in 355 genera of mosses, 675 species in 121 genera of liverworts and 25 species in six genera of hornworts were found (Dandotiya et al. 2011). However, in recent classification all three major groups of Bryophytes are placed separately into three lineages,

namely, Marchantiophyta (Liverworts), Anthocerotophyta (Hornworts), and Bryophyta (Mosses) (Goffinet et al. 2009).

Bryophytes play an important role as major ecological components of vegetation in many regions of the world. They represent a major part of biodiversity in moist forest, temperate forest, wetlands and tundra ecosystems having a major role in ecological succession. They have high water retention capacity due to their unique structure and for these reason they have tendency to grow mostly in humid and moist atmospheric conditions. As bryophytes lack outer protective cuticle layer, they are very much sensitive to different environmental pollutants. They play an important role as bio indicators of water pollution and also used to measure heavy metal air pollution (Hallingback and Hodgetts 2000). They are also used for monitoring the UV-B radiation, indicator of radioactivity, treatment of waste and waste management (Glime 2007). Bryophytes are rich in oligosaccharides, polysaccharides, sugar alcohols, amino acids, fatty acids, aliphatic compounds, prenylquinones & aromatic and phenolic compounds (Pant and Tewari 1990, Glime 2007). Reportedly, liverwort shows a variety of lipophilic terpenoids, aromatic compounds and acetogenins. Many of these compounds show extraordinary range of bioactivities and medicinal properties (Asakawa 2007).

There are several evidences that show people of China, India and Native Americans, use bryophytes in herbal medicine since ancient time. Ethno-bryology attains much attention by the scientist as these plants possess several medicinal properties but unfortunately very little ethno medicinal information is available in documented forms and much remains to be explored.

ETHNO-MEDICINALLY UTILIZED INDIAN BRYOPHYTES

Liverworts used by Indian Tribal communities

The simplest bryophytes are liverworts (Marchantiophyta), where plant bodies are simple or dorsiventrally differentiated thalloid or leafy. Since from the ancient time liverworts has been used as ethno medicine in various part of India (Table 1). Rao and Chatterjee (2014), made a survey in Shrikakulam district in north coastal Andhra, which is geographically located within 18°5'-19°12' N: 83°32'- 84°47' E. They reported that tribal communities of this district mainly residing in hilly and forest areas use some liverworts and other

bryophytes as ethno medicine for curing common disease including veterinary diseases. A total of six genera were reported among which two species were liverworts. The entire thallus of *Marchantia polymorpha* (Marchantiaceae) is used as medicine in liver ailments; for curing yellow jaundice and as a remedy against inflammation, whereas the young archegoniophore are used for the treatment of pulmonary tuberculosis. The entire thallus of another major liverwort *Riccia sp* (Ricciaceae) is also used by the tribal people as medicine. Fine paste of fresh thallus along with jaggery is used for curing children affected with ringworms and allied dermal diseases (Rao et al. 2014).

Shirsat (2008) reported that the tribal community of Melghat region (MS) India uses several lower plant groups as ethno-medicine. A total of four bryophytes and seven pteridophytes are mentioned in his research paper, which are used as ethno-medicine by the tribal people in that region. Among the four bryophytes, three were identified as liverworts. *Marchantia polymorpha* is used as ethno-medicine in the treatment of inflammation by making a fine paste of entire thalli followed by its external application on inflammation. *Riccia* is also reported as ethno-medicine, which is effective for the treatment of ringworm infection in children where the entire thallus is homogenized with jaggery and is given to the children orally. Another liverwort *Plagiochasma appendiculata* is also reported to be used in skin infection. Tribal people apply a fine paste of this plant on the concerned affected area (Shirsat 2008).

Two liverwort *Targionia hypophylla* and *Frullania ericoides* were also reported by Remesh et al. . in 2009 as an effective ethno-medicine widely used by tribal people of Western Ghat. They recorded these two liverworts from Attappady valley near to the Silent valley National Park of Western Ghats, Kerala. *Targionia hypophylla*, vernacularly known as Kallusinna to the Irula tribe, is used for the treatment of Scabies, itches, and other skin diseases. Irulars make a paste of this liverwort along with the leaves of *Actiniopteris radiata* (Pteridaceae). The roasted paste with a few tablespoons of coconut oil is applied on the affected areas of children's body. Leafy liverwort *Frullania ericoides*, also known as Mara Pasam to the Mudugar tribes of Attappady, is used for Head Lice (*Pediculus humanus*) removal treatment and for providing nourishment to hair follicles.

The ethno-medicinal use of *Plagiochasma appendiculata* Lehm. et Lindenb. by the Gaddi tribe of Kangra Valley, Himachal Pradesh was reported by Kumar et al. (2000). This liverwort is commonly known as

'Patharshali' to the tribal people. They use the whole thallus with female receptacle for the treatment of skin diseases in form of thick paste of the thallus and are externally applied for the treatment of burns, boils, and blisters on the body (Kumar et al. 2000).

Tag et al. (2007) mentioned ethno-medicinally important two liverworts, namely *Marchantia palmata* and *Marchantia polymorpha*. Ethno-botanical survey was performed by the authors in seven villages of Namsai reserve forest in Eastern Arunachal Pradesh. It was found that tribal people of this region mainly the Khamti tribe use these liverworts as herbal medicine due to their anti-inflammatory properties. Fresh leafy paste of *Marchantia palmata*, commonly known as Matakain, is applied directly on the inflammation caused by external burn injuries. Juice of *Marchantia polymorpha* or locally known as Matakainnung is also used in relieving inflammation on skin and eruption of pimples on face and body (Tag et al. 2007).

In an ethno-botanical survey in Eastern Himalaya region and adjoining areas by Mondal et al. (2009); seven ethno medicinally important liverworts, included *Conocephalum*, *Dumortiera*, *Frullania*, *Marchantia*, *Reboulia*, *Riccardia* and *Riccia* were reported. *Conocephalum* is used in healing cuts, boils, eczema and curing gall stones. The antimicrobial and antiseptic properties of *Dumortiera*, and *Frullania* was also reported. *Marchantia* was found effective in curing of all inflammations in liver, jaundice and pulmonary tuberculosis. *Reboulia* is used in external wound; *Riccardia* reportedly shows cytotoxicity against human epidermoid carcinoma and *Riccia* is effective in ringworm (Mondal et al. 2009).

Kani tribal communities of Agasthyamalai Biosphere Reserve of Kerala use various bryophytes as herbal medicine for first aid remedies. Some common liverworts such as *Marchantia polymorpha*, *Riccardia multifida*, *Plagiochila beddomei* are widely used by the Kani tribal people. For treatment of jaundice caused by hepatitis and for cooling and cleansing the liver *Marchantia polymorpha* is used. Warm leaf juice of *Riccardia multifida* is used in rheumatic swelling in cattle. It is also reported that *Plagiochila beddomei* is a very effective wound healing liverwort. Kani tribal people also use various mosses as herbal medicine. *Marchantia linearis* Lehm L. is used in skin diseases. During scorpion bite leaf paste is applied over the bitten area for relieve. In cold and cough, root powder is taken with cow's milk daily twice for three days. It also used to induce appetite. *Riccia frostii* is used for ringworm infection and also decoction of the plant is mixed with

vegetable oil for treatment against sores, cracked lips and skin allergy or hypersensitivity (Lubaina et al. 2014).

Mosses Used by Indian Tribal Communities

Mosses are the most advanced group in bryophytes, where mature gametophyte is green and differentiated into leaf like phylloid, stem like cauloid and root like rhizoids and scales. Sex organs are protected by sheathing leaves. Sporophytes are differentiated into foot and capsule or sometimes into foot, seta, and capsule. They exhibit different mechanisms for spore dispersion.

There are several reports on mosses being used traditionally as herbal medicine by the tribal people of India (Table 2). Three ethno-medicinally important mosses were reported from north coastal Andhra by Rao et al. (2014) which are widely used by the local tribal communities. Dried thalli mass of *Sphagnum* is used as surgical dressing in haemorrhage and blood loss. Decoction of thalli of this moss is used for curing optical and skin diseases. Fine hair of the capsule of *Sphagnum* is used by the tribal people for preparing hair tonic which helps to strengthen and beautify hair. Decoction of the plant body of *Polytrichum* is used in common fever, cold etc. It is also reported that this moss is boiled to prepare tea that helps in dissolving kidney and gall bladder stones (Rao et al. 2014).

Use of *Polytrichum* by the tribal communities of Melghat area (MS) has also been reported by Shirsat et al. (2008). This moss is reportedly used for hair growth by making fine powder of the plant body and is applied by mixing with hair oil. The paste of this moss is also used for wound healing (Shirsat et al. 2008).

Lubaina et al. (2014) reported that the Kani tribes of Agasthiyarmalai biosphere Reserve use various mosses as herbal medicine. *Rhodobryum giganteum* is eaten raw for the treatment of heart problems, nervous prostration and cardio vascular diseases. *Fissidens asperisectus* is used in sore throats, fever and paralysis. This moss is also used in dressing the wound. For treatment against pain relief caused by burn injuries, *Philonotis Fontana* is used. A moss *Aerobryum lanosum* is also used to treat burns. This moss is boiled with goat urine and is applied in affected area externally. It is also used in easy delivery in cattle and to treat bone fracture by applying it with bandage. *Entodon flavescens* is used to cure ear-ache. Its leaf juice is used as ear drops. Leaves of this moss crushed with same amount of pepper and garlic is taken for inducing female fertility. Kani tribal people also use *Fissidens flaccidus* for bandages. Leaves of this moss are used to prepare curry for curing

Table 1. List of Liverworts used as Ethno medicine by different Indian tribal Communities

Tribal communities	Liverworts used	Family	Medicinal implications	References
Adivasi Oriya and telegu (Srikakulam district, North Coastal Andhra)	<i>Riccia sp.</i> <i>Marchantia polymorpha</i> L.	Ricciaceae Marchantiaceae	Paste of the thallus used for Ringworm infection in children Liver ailments, Yellow jaundice; young archegoniophor treats Pulmonary Tuberculosis.	Rao et al. 2014.
Tribal people of Melghat forest	<i>Marchantia polymorpha</i> L. <i>Riccia sp.</i> <i>Plagiochasma appendiculata</i> Lehm. & Lindenb.	Marchantiaceae Ricciaceae Aytoniaceae	Reduce inflammation Used to treat against ringworm in children Used in treatment of skin disease	Shirsat 2008.
Irula tribes (Atapaddy valley, Palakkad District, Kerala).	<i>Targionia hypophylla</i> L.	Targioniaceae	Effective in Scabies, itches and other skin diseases	Remesh et al. 2009
Muduga tribes (Atapaddy valley, Palakkad District, Kerala)	<i>Frullania ericoides</i> (Nees ex Mart.) Mont.	Frullaniaceae	Used to treat Head Lice and nourishment of hair.	Remesh et al. 2009
Gaddi tribe, (Kangra valley, Himachal Pradesh)	<i>Plagiochasma appendiculata</i> Lehm. & Lindenb.	Aytoniaceae	Female receptacle used for skin disease, paste of the thallus. externally used for burn, blisters etc	Kumar et al. 2000.
Khamti tribe (Namsai reserve forest, Arunachal Pradesh)	<i>Marchantia palmata</i> Nees & Blume.	Marchantiaceae	Reduce inflammation caused by touch of fire and hot water	Tag et al. 2007
Tribes of Eastern Himalaya and adjoining areas	<i>Marchantia polymorpha</i> L. <i>Conocephalum sp.</i> <i>Dumortiera sp.</i> <i>Frullania sp.</i> <i>Marchantia sp.</i>	Marchantiaceae Marchantiaceae Dumortieraceae Frullaniaceae Marchantiaceae	Relieves inflammation on skin; pimples on face and body. Used for burns, boils, cuts, eczema; also in poisonous snake bite It has antimicrobial properties It has antiseptic activity Curing jaundice, pulmonary tuberculosis; healing cuts, wounds, marks of small pox etc	Mondal et al. 2009.
Kani tribal communities of Agasthiyarmalai Biosphere Reserve, Kerala.	<i>Reboulia sp.</i> <i>Riccardia sp.</i> <i>Riccia sp.</i> <i>Riccardia multiifida</i> (L.) Gray <i>Plagiochila sp.</i> <i>Marchantia polymorpha</i> L. <i>Marchantia inearis</i> Lehm & Lindenberg <i>Riccia frostii</i> Austin	Aytoniaceae Anuraceae Ricciaceae Anuraceae Plagiochilaceae Marchantiaceae Marchantiaceae Ricciaceae	Cure blotches on skin, external wounds; also has haemostatic effect It shows cytotoxicity against human epidermoid carcinoma. Decoction of the plant effective in ringworm Used to treat rheumatic swelling in cattle; leaves crushed with pepper are taken orally in stomachache Effective in wound healing Used in Jaundice, cooling and cleansing liver, curing leucorrhoea, reduce external inflammation etc. Used in skin diseases, cold and cough, helps to reduce pain in scorpion bite. Treating ringworm and also used against sores, crack lips and skin allergy.	Lubaina et al. 2014

Table 2. List of mosses used as ethnomedicine by different Indian tribal communities

Tribal communities	Ethno medicinally used mosses	Family	Medicinal implications	References
Adivasi Oriya and telegu , Srikakulam district, North Coastal Andhra	<i>Sphagnum sp.</i> <i>Polytrichum sp.</i>	Sphagnaceae Polytrichaceae	Cure eye and skin disease, in haemorrhage it is used as surgical dressing Used in common fever and cold, using this plant as tea helps in dissolving gall bladder and kidney stone. Also helps beautify and strengthen hair.	Rao et al. 2014
Tribal people of Melghat forest.	<i>Polytrichum sp.</i>	Polytrichaceae	Thallus paste is used for wound healing, fine powder of the thallus mixed with oil applied to hair for improving hair growth	Shirsat 2008
Kani tribes of Agasthyamalai biosphere Reserve (Kerala)	<i>Rhodobryum giganteum</i> (Schwagr.) Paris <i>Fissidens asperisetus</i> Sande Lac. <i>Philonotis fontana</i> (Hedw.) Brid. <i>Aerobryum lanosum</i> (Mitt.) Mitt. <i>Entodon flavescens</i> (Hook.) A. Jaeger <i>Fissidens flaccidus</i> Mitt. <i>Hyophila attenuate</i> Broth. <i>Frullania acutiloba</i> Mitt. <i>Atrichum undulatum</i> (Hedw.) P. Beauv. <i>Polytrichum commune</i> Hedw. <i>Barbula indica</i> (Hook.) Spreng.	Bryaceae Fissidentaceae Bartramiaceae Meteoriaceae Entodontaceae Fissidentaceae Pottiaceae Frullaniaceae Polytrichaceae Polytrichaceae Pottiaceae	Leaf extract with seven crushed peppers used in menstrual pain; effective in heart problems, cardiovascular diseases etc. Used in sore throats, fever and paralysis; also for dressing wounds Relieve pain in burns Paste of the plant with goat urine used externally in bone fracture. Leaf juice used as ear drops, reduce earache, boost female fertility. Curry of the plant cure mouth ulcer; used in leucorrhea, malaria. Effective in skin infection, cold, cough and neck pain. Used in treatment of burns. Dry stem powder with neem oil used to treat baldness and dandruff. Strengthen hairs, increase sexual vigor, effective in gout, treats mouth ulcer, toothache etc. effective against epidermoid carcinoma; leaf extracts used in menstrual pain etc	Lubaina et al. 2014

Table 3. List of Bryophytes used as Ethno Medicine in other Countries

Country	Bryophytes	Family	Medicinal uses	References
China	<i>Conocephalum conicum</i>	Marchantiaceae	Used to treat bites, boils, burns, cuts, eczema, and wounds.	Wu 1977; Ando 1983
	<i>Marchantia polymorpha</i> <i>Polytrichum commune</i> Hedw.	Marchantiaceae Polytrichaceae	Treat bites, boils, burns, cuts, eczema etc. Helps in reducing inflammation and fever: for treating the common cold and also helps dissolve stones of kidney and gall bladder	Gulabani 1974, Gilm 2007 ZhongHua BenCao 1999
Utah, USA	<i>Dicranum majus</i> Turner	Dicranaceae	Used for clear lungs and stops cough	ZhongHua BenCao 1999
	<i>Pogonatum inflexum</i> (Lindb.) Sande Lac.	Polytrichaceae	Used for sedation and to calm nerves, blood spots and bruises; also treat heart palpitations, insomnia and injuries	Du 1994
	<i>Atrichum undulatum</i> (Hedw.) P. Beauv.	Polytrichaceae	Used as anticancer medicine (ZhongHua BenCao 1999
	<i>Weissia controversa</i> , Hedw.	Pottiaceae	Use to cure of inflammation of the nose or sinuses	Flowers 1957, Gilm 2007
Philippines	<i>Bryum</i> sp.	Bryaceae	Paste made out of the plants applied as poultice to reduce the burn pain	
	<i>Mnium</i> sp.	Mniaceae		
	<i>Philonotis</i> sp.	Bartramiaceae		
	<i>Riccardia</i> sp.	Aneuraceae	Exhibits anti leukemic activity.	Azueto et al. 2011
	<i>Herbertus</i> sp.	Herbertaceae	Used as antiseptic.	Azueto et al. 2011
	<i>Dumortiera hirsute</i>	Marchantiaceae	Used as source for antibiotics	Azueto et al. 2011
	<i>Marchantia</i> sp.	Marchantiaceae	Used for liver diseases, snake bites etc.	Azueto et al. 2011
	<i>Pallavicinia</i> sp.	Pallaviciniaceae	antimicrobial activity.	Azueto et al. 2011
	<i>Philonotis</i> sp.	Bartramiaceae	Used to set broken bones.	Azueto et al. 2011
	<i>Rhodobryum giganteum</i> (Schwagr.) Paris	Bryaceae	The extract is used to cure angina	Wu 1977
U.K.	<i>Bryum</i> sp.	Bryaceae	Used to treat broken bones, fever and body aches	Sturtevant 1954
	<i>Fissidens nobilis</i> ,	Fissidentaceae	Encourage hair growth	Harris 2002
	<i>Plagiomnium</i> sp.,,	Mniaceae	used for blood blisters, breast abscesses	
	<i>Mnium</i> sp.,	Mniaceae	Used to set broken bones	
	<i>Polytrichum</i> sp.	Polytrichaceae	Used to speed up the labor process	Turner et al. 1983
	<i>Barbula</i> sp.,	Pottiaceae	It shows antirheumatic properties, used in fever and body aches	Sturtevant 1954
	<i>Sphagnum sericeum</i> C. Mull	Sphagnaceae	It has anti- microbial properties and also used in dressing wounds.	Azueto et al. 2011
	<i>Marchantia polymorpha</i> L.	Marchantia	Used for 'a binding at the heart' and as diuretic for Dropsy.	Allen et al. 2004
	<i>Fontinalis antipyretica</i> Hedw.	Fontinalaceae	Used to staunch bleeding.	Allen et al. 2004
	<i>Sphagnum</i> sp.	Sphagnaceae	Used for antiseptic activity.	Allen et al. 2004
Peru	<i>Anthoceros</i> sp.	Anthocerotaceae	Reported to have some medicinal properties	Watt 1889.
	<i>Lunularia cruciata</i>	Lunulariaceae	Used to treat kidney problems, remedy for fainting in married women	Franquemont et al. 1990
	<i>Polytrichum commune</i> Hedw.	Polytrichaceae	Chewed by women in labor helps speeding up the process	Moerman 1998, Turner et al. 1983
	<i>Pellia</i> sp.	Pelliaceae	used to treat in children for sore mouth or throat	Turner & Efrat 1982
Bolivia	<i>Fissidens flexinervis</i> Mitt.	Fissidentaceae	Used to treat digestive problems.	Boom 1996
	<i>Isopleygiium tenerum</i> (Sw.) Mitt.	Hypnaceae	Use in the treatment of rheumatism.	Boom 1996
New Zealand	<i>Thuidium schistocalyx</i> (Mull. Hal.) Mitt.	Thuidiaceae	Decoction is taken as drink to cure headache in Bolivia	Boom 1996
	<i>Lembophyllum clandestinum</i> (Hook.f. &Wilson) Lindb.	Lembophyllaceae	Used as a wrapper or absorbent, also used by steeping in water and applied to the affected part in venereal disease	Brooker et al. 1987
Vietnam	<i>Taxiphyllum taxirameum</i> (Mitt.) M.Fleisch.	Hypnaceae	Used for external bleeding	Vo 1997, 1999

mouth ulcer and leaf juice is used for the treatment of leucorrhoea and malaria. *Barbula indica*, is effective against epidermoid carcinoma. Its leaf extract is also used in relieving menstrual pain. *Hyophila attenuate* is very effective in fungal skin infection. The leaf extract with a pinch of pepper powder is also effective against cold, cough and neck pain. The extract of aerial parts of *Frullania acutiloba*, crushed with cumin seeds is used in case of burns. The paste of dried stem of *Atrichum undulatum* along with Neem oil is used to treat baldness and dandruff. It is also effective in treating dysentery. *Polytrichum commune* is taken by the Kani tribes for reducing inflammation and fever, and in treatment of kidney and gallstones. The whole plant paste is externally applied as ointment for the treatment of gout. It is also reported that oil extracted from its calyptra is used for strengthening and hair beautification. Entire plant extract is taken daily once in a fortnight to increase sexual vigor. This moss is also used in the treatment of mouth ulcer, toothache, detergent diuretic, laxative and hemostatic agent.

Ethno-medicinally Important Bryophytes Reported From Other Parts of the World

There are several reports on use of bryophytes as herbal medicines throughout the world (Table 3). Chinese and Native Americans use the bryophytes as herbal medicine since the ancient time. It is reported that in China, *Sphagnum* is used for treatment of haemorrhages (Bland 1971). Cardiovascular diseases and nervous prostration can be treated using *Rhodobryum giganteum* and *R. roseum*. *Polytrichum commune* helps in reducing inflammation and fever (Hu 1987). *Haplocladium microphyllum* is effectively used to treat cystitis, bronchitis, tonsillitis, and tympanitis. Mixture of *Conoccephalum conicum* and *Marchantia polymorpha* with vegetable oils is also used to treat bites, boils, burns, cuts, eczema, and wounds (Wu 1977, Ando 1983). *Fissidens* is used as an antibacterial agent for treatment of swollen throats and also against other symptoms of bacterial infections. *Polytrichum commune* is used for treating the common cold and also helps to dissolve stones of kidney and gall bladder (Gulabani 1974, Glime 2007). *Polytrichum juniperinum* is used as medicines in Montana by Cheyenne (Hart 1981). In Utah, *Bryum*, *Mnium*, *Philonotis* and various matted Hypnaceous forms are used by the Gasuite Indians by grinding them into a paste and are applied to reduce the pain caused due to severe burns (Flowers 1957, Glime 2007).

Azuelo et al. (2011) reported some medicinal bryo-

phytes along with their morphological features and ethnic uses, from the two mountainous regions namely Mt. Kalatungan and Mt. Kitanglad in Bukidnon, the Philippines. They reported a total of seventeen species of medicinal Bryophytes from Mt. Kitanglad and fourteen species of medicinal Bryophytes from Mt. Kalatungan. Some of the important medicinal mosses are *Philonotis* sp., *Rhodobryum giganteum*, *Bryum* sp., *Fissidens nobilis*, *Plagiomnium* sp., *Mnium* sp., *Dawsonia* sp., *Pogonatum macrophyllum*, *Polytrichum* sp., *Barbula* sp., *Sphagnum sericeum* etc. There are also reports of some medicinally important Liverworts such as *Riccardia* sp., *Herbertus* sp., *Dumortiera* sp., *Marchantia* sp., *Pallavicinia* sp., *Plagiochila* sp. *Philonotis* sp is used as padding under splints to set broken bones. Extract of *Rhodobryum giganteum* has been reportedly used to cure angina and cardiac disorders (Wu 1977). *Bryum* sp is also used to treat broken bones and is applied externally to cure body aches (Sturtevant 1954). *Fissidens nobilis* is burned and applied on the head by Native Americans to encourage the hair growth (Harris 2002). Leaves of *Plagiomnium* sp. is crushed and used for blood blisters, breast abscesses. *Mnium* is also used to set broken bones by native peoples. *Polytrichum* sp is chewed when women are in labor pain as it speeds up the labor process (Turner et al. 1983). *Dawsonia superb* is reported to be very effective in diuretic & renal treatment and also helps in hair growth stimulation. *Sphagnum sericeum* has anti-microbial properties and is also used in dressing wounds. *Barbula* sp shows antirheumatic properties and is also used in fever and bodyaches (Sturtevant 1954). Liverworts such as *Riccardia* sp., exhibit anti-leukemic activity whereas *Herbertus* sp has antiseptic and antidiarrhoeal properties. *Dumortiera hirsuta* is used as source of antibiotics and *Marchantia* sp is used as a medicine for cure of liver diseases, hepatic disorders and snake bites etc. There is report on *Pallavicinia* sp having antimicrobial property too (Azuelo et al. 2011).

Allen and Hatfield in 2004 mentioned some medicinally important bryophytes used in Folk tradition. *Marchantia polymorpha* is used for 'a binding at the heart' and as diuretic for Dropsy in Berwickshire. *Fontinalis antipyretica* is used to staunch bleeding in Limerick. In Ireland, *Sphagnum* is well known for its antiseptic properties. In Westmeath, the moss is simply left on wounds or sores after wash, or clay is used to plaster over it (Allen et al. 2004).

Harris (2008) reported around 150 ethno-botanically important Bryophytes most of which are used in Traditional Chinese medicine and also by native North Americans. *Sphagnum*, *Polytrichum* and *Marchantia* are

the most common ethno-botanical bryophytes. A hornwort *Anthoceros* is reported from UK to have some medicinal properties too (Watt, 1889). *Concephalum conicum* is marked as medicinal plant in different countries such as Canada, China, and France. This liverwort is mainly used in various skin problems. In Peru, *Lunularia cruciata* is used to treat kidney problems and as a remedy for fainting in married women. Whole plant is boiled and taken as tea (Franquemont et al. 1990). *Dicranum majus* is reported from China and is used for clearing lungs and stopping cough in pulmonary diseases (ZhongHuaBenCao 1999). In China, *Pogonatum inflexum* is used for sedation and to calm nerves, blood spots and bruises. It is also used to treat heart palpitations, insomnia and injuries (ZhongHua BenCao 1999). *Artichum undulatum* is reportedly used as an anticancer medicine in China (Du 1994). Another moss *Weissia controversa* is reported from China to cure inflammation of the nose or sinuses (ZhongHua BenCao 1999). In Canada, *Polytrichum commune* moss is chewed by women in labor pain which helps in speeding up the delivery process (Moerman 1998, Turner et al. 1983). Species of *Pellia* is used to treat children for sore mouth or throat in Canada by drinking it in the form of juice or chewing the fleshy pulp of the liverwort (Turner and Efrat 1982). In Bolivia, *Fissidens flexinervis* is used to treat digestive problems; *Isopterygium tenerum* is reported to have anti-rheumatic property and *Thuidium schistocalyx* decoction is taken as a drink to cure headache (Boom 1996). The moss *Lembophyllum clandestinum* is used as a wrapper or absorbent in New Zealand and is also used by steeping in water for application to the affected part in venereal disease (Brooker et al. 1987). In Vietnam, *Taxiphyllum taxira-meum* is used for external bleeding (Vo 1997, Vo 1999).

CONCLUSION

Thus, it is evident that Bryophytes, the non-vascular simple plant group, are used by various tribal communities in India as well as in other countries as effective herbal medicine since prehistoric time. Most of the tribal communities in India use liverworts for treating Liver diseases, skin diseases as well as for external pain issues, burns, cuts etc. *Marchantia* is used by various tribes for curing Jaundice, Liver problems, and cleansing liver. *Riccia* is reportedly used for the treatment of ringworm in children. There are other

liverworts like *Plagiochasma appendiculata*, *Conocephalum sp.*, *Dumortiera*, *Targionia*, which show effective anti inflammation and antimicrobial property. They are very much effective in skin diseases also. Mosses like *Sphagnum*, *Polytrichum*, *Rhodobryum*, *Bryum*, *Fissidens*, *Barbula* etc are also used by the Tribal people as traditional medicine. *Sphagnum* is used for treatment of eye diseases and in surgical dressing. *Polytrichum* is used to strengthen and beautify hair. In China *Rhodobryum gigantium* is used to treat cardiovascular diseases and nervous prostration. Kani tribal people use *Barbula indica* reported to be effective against epidermoid carcinoma. However, there are very few reports about Hornworts used as ethno medicine by the tribal people. Only from U.K it is reported that Hornwort *Anthoceros* has some medicinal properties (Watt 1889). Therefore more investigations are required on Hornworts from the ethno medicinal point of view.

India is a mega diversity nation with a rich and varied traditional knowledge. There are various tribal communities dispersed throughout India who utilizes this ancestral traditional knowledge to treat their basic health issues and ailments. Bryophytes form a major source of unreported herbal medicines used by those tribal communities. The present investigation deals with only a few of those information gathered from the above mentioned tribal communities such as adivasi people of Oriya, adivasi Telegu, Irula, Muduga, Gaddi, Khamti, Kani, and other tribal communities from Himalayan region and Melghat Forest region etc. but much remains unexplored. Thus the present project aims to unravel the underutilized traditional bryological knowledge and aid in advanced ethno botanical implications for the betterment of mankind.

Currently ethno medicinally used bryophytes gained much attention by the researcher as it opens up new dimensions in discovery of unexplored drugs from bryophytes. It is a proven fact that bryophytes are enriched with various chemical compounds possessing medicinal properties, therefore further scientific investigation with modern knowledge is required to discover and design new drugs for enhancement of better human health services.

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REFERENCES

- Allen, E.D. and Hatfield, G. 2004. Medicinal Plants in Folk Tradition An Ethnobotany of Britain and Ireland. Timber Press, London. 39 pages
- Ando, H. 1983. Use of Bryophytes in China 1. Proceedings of the Bryological Society of Japan, Tokyo 3: 104-106.
- Asakawa, Y. 2007. Biologically active compounds from bryophytes. Pure and Applied Chemistry 79 (4): 557-580.
- Azuelo, G.A.; Sariana, G.L. and Pabualan, P.M. 2011. Some medicinal bryophytes: their ethnobotanical uses and morphology. Asian Journal of Biodiversity 2: 49-80.
- Bland, J.H. 1971. Forests of Lilliput: The Realm of Mosses and Lichens. Prentice- Hall, Englewood Cliffs, NJ. 210 pages
- Boom, B.M. 1996. Ethnobotany of the Chacobo Indians, Beni, Bolivia. Advances in Economic Botany 4: 1-68.
- Dandotiya, D.; Govindaparyari, H.; Suman, S. and Uniyal, P.L. 2011. Checklist of the bryophytes of India. Archive for Bryology 88: 1-20.
- Du, Z.X. 1997. A study of medicinal bryophytes used in Guangxi province, S China. Chenia 3-4: 123-124.
- Flowers, S. 1957. Ethnobotany of the Gosiute Indians of Utah. The Bryologist 60: 11-14.
- Flowers, S. 1957. Ethnobotany of the Gosiute Indians of Utah. The Bryologist 60: 11-14.
- Franquemont, C.; Plowman, T.; Franquemont, E.; King, S.R.; Niezgodna, C.; Davis, W. and Sperling, C.R. 1990. The Ethnobotany of Chinchero, an Andean community in Southern Peru. Fieldiana, Botany 24: 1-126.
- Glime, M.J. 2007. Economic and Ethnic Uses of Bryophytes. Flora of North America 27: 14-41.
- Goffinet, B.; Buck, W.R. and Shaw, A.J. 2009. Morphology, anatomy, and classification of the Bryophyta. Pages 55-138, In: Goffinet, B. and Shaw, A.J. (Editors), Bryophyte Biology, 2nd edition. Cambridge University Press, Cambridge.
- Gulabani, A. 1974. Bryophytes as economic plants. Botanica 14:73-75.
- Halder, K. and Chakraborty, S. 2018. An account of antioxidant potential in pteridophytes: a biochemical perspective. International Journal of Bioinformatics and Biological Science 6: 15-24.
- Hallingback, T. and Hodgetts, N. 2000. Mosses, Liverworts and Hornworts. Status survey and conservation Action Plan for Bryophytes. IUCN/SSC Bryophyte Specialist Group, Gland, Switzerland.
- Harris, E. 2002. An examination of phylogenetic characters in mosses: Examples from *Fissidens* Hedw. (Fissidentaceae: Musci). Presentation and abstract presented at the annual meeting of the American Bryological and Lichenological Society, 26-27 July 2002, Storrs, CN, USA.
- Harris, E.S.J. 2008. Traditional Uses and Folk Classification of Bryophytes. The Bryologist 111: 169-217.
- Hart, J. 1981. The Ethnobotany of the Northern Cheyenne Indians of Montana. Journal of Ethnopharmacology 4: 1-55.
- Hu, R. 1987. Bryoplogy. Higher Education Press, Beijing. 465 pages.
- Kumar, K.; Singh, K.K.; Asthana, K.A. and Nath, V. 2000. Ethno-therapeutics of bryophyte *Plagiochasma appendiculatum* among the Gaddi Tribes of Kangra Valley, Himachal Pradesh, India. Pharmaceutical Biology 38: 353-356.
- Lubaina, A.S.; Pradeep, D.P.; Aswathy, J.M.; Krishnan, R. and Krishnan, V.G. 2014. Traditional knowledge of medicinal Bryophytes by the Kani tribes of Agasthiyarmalai Biosphere reserve, Southern Western Ghats. Indo American Journal of Pharm Research 4: 2116-2121.
- Moerman, D.E. 1998. Native American Ethnobotany. Timber Press, Portland. 427 pages
- Mondal, K.A. and Mondal, S. 2009. Ethnobotany- Seeking More Deserving Future. Frontiers in Biology 1: 31-36.
- Pant, G. and Tewari, S.D. 1990. Bryophytes and mankind. Ethnobotany 2: 97-103.
- Rao, N.M.G. and Chatterjee, R. 2014. Folklore utilisation of bryophytes amongst the tribal regions of north coastal Andhra. International Journal of Environment 3: 101-108.
- Remesh, M. and Manju, N. C. 2009. Ethnobotanical notes from Western Ghats, India. The Bryologist 112 (3): 532-537.
- Shirsat, P.R. 2008. Ethnomedicinal uses of some common lower plants used by tribals of Melghat Region (MS), India. Ethnobotanical Leaflets 12: 667-669.
- Sturtevant, W. 1954. The Mikasukiseminole: Medical Beliefs and Practices. Ph. D. Dissertation. Yale University. 203 pages.
- Tag, H.; Das, K.A. and Loyi, H. 2007. Anti-inflammatory plants used by the Khanti tribe of Lohit district in Eastern Arunachal Pradesh, India. Natural Product Radiance 6: 334-340.
- Turner, N.J. and Efrat, S.B. 1982. Ethnobotany of the Hesquiat Indians of Vancouver Island. Cultural Recovery Paper 2: 1-101.
- Turner, N.J.; Thomas, J.; Carlson, B.F. and Ogilvie, R.T. 1983. Ethnobotany of the Nitinaht Indians of Vancouver Island. Victoria. British Columbia Provincial Museum, p. 59.
- Vo, V.C. 1997. Dictionary of Medicinal Plants of Vietnam. Medicine Publisher, Hanoi. 984 pages.
- Vo, V.C. 1999. Useful Plants and Herbs of Vietnam. Vol. 1. Education Publishing Company, Hanoi.
- Watt, G. 1889. Dictionary of the Economic Products of India. Vol. V. W. H. Allen & Co, London. 85 pages
- Wu, P.C. 1977. *Rhodobryum giganteum* (Schwaegr.) Par. can be used for curing cardiovascular disease. Acta Phytotaxonomica Sinica 15: 93.
- ZhongHua BenCao Editorial Committee, State Administration of Traditional Chinese Medicine (Zhonghua). 1999. Zhonghua Bencao (The Chinese Herbal). Chinese Materia Medica. Volume 2. Shanghai Science and Technology Press, Shanghai.

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