The word ‘Lichen’ was first coined by Theophrastus in about 300 B.C. to describe outgrowths from the bark of olive trees (Hawksworth and Hill, 1984). Lichen thallus comprised of a fungus and one or more extracellularly located alga or cyanobacteria, growing together in mutualistic associations (Hawksworth, 2000). All three component i.e. alga, cyanobacteria and mycobiont in various combinations are also common (Hawksworth, 1988). Lichen is also referred as self-contained ecosystem as all the partners involved in the association are relatively stable and well-balanced (Farrar, 1976; Seaward, 1988).

Dr. D.D. Awasthi also known as ‘Father of Indian Lichenology’ has started the work in midfifties of 20th century at Lucknow University. Lucknow, India is rich in lichen diversity, presently 2305 species of lichens have been reported so far, out of which about 22.6 % species are endemic (Singh and Sinha, 2010). Lichens played an important role in plant succession and can be defined as composite organism consisting of two distinct and dissimilar components- the mycobiont and the phycobionts. There are about 18,800 known lichen taxa.

Since the fungal constituent usually dominates the association, lichens traditionally have been considered as a lifestyle of fungi (Feuerer and Hawksworth 2007). Monumental work on lichens was done by -Father of Taxonomy; Carolus Linnaeus (1707- 1778), a Swedish naturalist who mentioned Lichen fusiformis (L.) DC (Roccella montagnei Bel.) in his “Species Plantarum”. Lichens described in Species Plantarum were the collection of Linnaeus himself. Erik Acharius, last student of Linnaeus, -The father of Lichenology, studied the specimens collected by Linnaeus and created many new genera and documented in his work- Lichenographiæ suecicæ prodromus (1798); Methodus lichenum (1803);
Lichenographia universalis (1810) and Synopsis methodicaLichenum (1814).

However, the first ever record of lichen collection from India is known to be Belanger (1834-38) from Pondicherry and Coromandal coast. Lichens have been problematic organisms since Simon Schwendener in the 1860s (Schwendener 1869) discovered their so-called -double nature, and showed that they are a consortium of algae and fungi. The emphasis on the conservation of biodiversity has been felt by the concerned working authorities, which have purposely opened many institutions in the country and the world. The Natural History Museum; has some very good collection of plant specimens including those of lichens, which were the pioneer collection of Linnaeus, Acharius and other lichenologists. The Royal Society of England; reflected in its founding Charters of the 1660s, to recognize, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity. The Royal Botanical Garden, Kew, is the largest Herbarium and has a vast collection of algae, fungi, lichens, bryophytes, pteridophytes and angiosperm plants. In India, the Central National Herbarium (CNH, Kolkata) attached to Head Quarters, Botanical Survey of India; Kolkata is the largest herbarium in the country. The present study approached to study in not only classical concepts of lichen biology but also focused on the modern scientific applications such as biotechnology, nanotechnology, etc for the better study of the conservation bioprospective study of the lichens. The work on lichens in India is of ancient origin. Charilla, a mixture of lichens, mainly Parmotrema spp., Everniastrum cirrhatum; is in use from the ancient times. Dr. Dharani Dhar Awasthi, (Awardee of 1st Acharius Medal, Fellow of Indian National Science Academy and Fellow of Indian
Academy of Sciences) who is also considered as Father of Indian Lichenology mainly documents the work on lichens in India. The Indian lichen flora is represented by approximately 2350 species included under 305 genera, listed in 74 families.

Definition - **Lichen is an association of a fungus and an alga or cyanobacteria (both) in which the two organisms are so interwined as to form a single thallus** (Alexopoulos and Mims, 1979).

The lichens can be broadly classified into two types: **Macrolichens** (squamulose, foliose and fruticose) and **Microlichens** (crustose, lirillate). The thalloid form of compact light-exposed vegetative bodies of lichens, constitute the most complex and aesthetically pleasing morphologies evolved by fungi during the past 600 million years (Yuan et al., 2005).

Many lichens are highly extreme-tolerant which allows them to live as pioneers in the alpine zone and other cold environments. Life under these conditions correlates with the production of a variety of compound classes. Several of these metabolites are already reported in plants or in other fungi, but reach highest upto 80 per cent in lichens (Huneck and Yoshimura, 1996).

The distribution patterns of secondary metabolites are usually taxon-specific and, therefore, have been widely used in lichen taxonomy and systematics (Piercey-Normore, 2007; Nelsen and Gargas, 2008). Lichens synthesize numerous metabolites, the -lichen substances, which comprise **amino acid derivatives, sugar alcohols, aliphatc acids, macrocyclic lactones, mono-cyclic aromatic compounds, quinones, chromones, xanthhones, dibenzofuranes, depsides, depsidones, depsones, terpenoids, steroids, carotenoids and diphenyl ethers** (Clix et al., 1984; Fiedler et al., 1986). The probability of finding good compounds to
be used as drug in polyketides is extremely high, about 1 in 100 compounds, which in about 1 in 5000 in case of normal compounds (Borchardt, 1999). Many famous polyketide drugs are already present in the market such as Erythromycin A (antibiotic), rapamycin (immunosuppressant), lovastatin (cholesterollowering agents) etc. (Weismann, 2004). These secondary compounds give these lichens a very characteristic smell, taste and colour; which are also taxonomically very significant and strengthen the base of chemotaxonomy. These compounds in lichen serve many purposes including self-protection through anti-herbivory (Lawry, 1989), anti-larval action (Emmerich et al., 1993) or nematicidal action (Ahad et al., 1991) and insecticidal action (Hesbacher et al., 1995). Burkholder reported for the first time the presence of antibiotic substances in lichens (Burkholder et al., 1944). The well known antibacterial topical drug in the market sold under the names of -USNO and -EVOSIN throughout the European countries has usnic acid as one of the major constituent (Dayan and Romagni, 2002).

A total of five lichen species *Roccella montagnei* Bel, *Usnea longissima*, *Cetrelia braunsiana* (Mull Arg) Culb. and Culb, *Cladonia rangiferina* (L) Weber and *Parmotrema reticulatum* (Taylor) M. Choisy were collected from Gujrat, Sikkim, on Pinus, Sela Pass and Kerala respectively. These lichens were collected from the Herbarium of National Botanical Research Institute, NBRI, Lucknow. The lichen thallus for extraction were cleaned, washed and airdried. They were crushed and allowed to undergo the soxhlet extraction with methanol, ethanol, ethyl acetate and acetone as solvents, followed by rotary evaporator. Stock solution was made by adding distilled water and Dimethyl Sulfoxide, DMSO. Firstly, these were chemically tested by
Thin layer chromatography. Antimicrobial assays were performed to test
the efficacy of acetone extracts against fungal and bacterial pathogens.

These species of lichens were tested for their antimicrobial efficacy
against a wide range of microbes including *Pseudomonas aeruginosa,*
*Staphylococcus aureus,* *Streptococcus mutans,* *Agrobacterium
tumefaciens,* *Escherichia coli* and *Klebsiella pneumoniae* as bacterial
pathogens and *Candida albicans,* *Aspergillus niger* and *Fusarium
oxysporum* as fungal pathogens.

Plant based secondary metabolites produced as a result of various
biosynthetic pathway mainly consists of alkaloids, terpenoids, flavonoids,
phenolics, etc as major active compounds which possess various
biological activities such as antimicrobial potential, antioxidant, enzyme
inhibitory etc. The maximum percentage yield was found in *Usnea
longissima,* followed by *Roccella montagnei* Bel, *Parmotrema
and Culb and Culb and *Cladonia rangiferina* (L) Weber.

**In Roccella montagnei Bel,** the Ethanolic extract inhibited the growth of
all the organisms tested and specially exhibited 28-34 mm zones of
inhibition against *Staphylococcus aureus,* *Streptococcus mutans,*
*Escherichia coli,* *Candida albicans* and *Fusarium oxysporum.* The
various concentrations (5-20%) of Ethanolic extracts exhibited more
effective zone of inhibition compared to the antibiotic standard
Streptomycin (25-28 mm) against *Staphylococcus aureus* and
*Escherichia coli* (28-32 mm) also compared to the antifungal standard
Ketoconazole (14-15 mm) against *Aspergillus niger,* *Candida albicans
and Fusarium oxysporum* (25-28 mm).
**In Usnea longissima,** The Methanolic extract inhibited the growth of all the organisms tested and specially exhibited 30-34 mm zones of inhibition against *Staphylococcus aureus, Streptococcus mutans, Escherichia coli, Candida albicans and Fusarium oxysporum.* The various concentrations (5-20%) of Methanolic extracts exhibited more effective zone of inhibition compared to the antibiotic standard Streptomycin (25-28 mm) against *Staphylococcus aureus* and *Escherichia coli* (28-32 mm) also compared to the antifungal standard Ketoconazole (14-15 mm) against *Aspergillus niger, Candida albicans and Fusarium oxysporum* (16-18 mm).

**In Cetreria braunsiana (Mull Arg) Culb. and Culb,** The Methanolic extract inhibited the growth of all the organisms tested and specially exhibited 25-30 mm zones of inhibition against *Staphylococcus aureus, Agrobacterium tumefaciens, Escherichia coli, Candida albicans and Fusarium oxysporum.* The various concentrations (5-20%) of methanolic extracts exhibited more effective zone of inhibition compared to the antibiotic standard Streptomycin (22-25 mm) against *Staphylococcus aureus* and *Escherichia coli* (28-32 mm) also compared to the antifungal standard Ketoconazole (12-14 mm) against *Aspergillus niger, Candida albicans and Fusarium oxysporum* (28-32 mm).

**In Cladonia rangiferina (L) Weber,** The Ethyl acetate extract inhibited the growth of all the organisms tested and specially exhibited 20-24 mm zones of inhibition against *Staphylococcus aureus, Klebsiella pneumoniae, Escherichia coli, Candida albicans and Fusarium oxysporum.* The various concentrations (5-20%) of Ethyl acetate extracts exhibited more effective zone of inhibition compared to the antibiotic standard Streptomycin (20-24 mm) against *Staphylococcus aureus* and *Escherichia coli* (28-32 mm) also compared to the antifungal standard...
Ketoconazole (12-14 mm) against Candida albicans and Fusarium oxysporum (18-20 mm).

In Parmotrema reticulatum (Taylor) M. Choisy, The Ethyl acetate extract inhibited the growth of all the organisms tested and specially exhibited 20-24 mm zones of inhibition against Staphylococcus aureus, Streptococcus mutans, Escherichia coli, Candida albicans and Fusarium oxysporum. The various concentrations (5-20%) of Ethyl acetate extracts exhibited more effective zone of inhibition compared to the antibiotic standard Streptomycin (18-22 mm) against Staphylococcus aureus and Escherichia coli (20-24 mm) also compared to the antifungal standard Ketoconazole (12-14 mm) against Fusarium oxysporum (28-30 mm).

Thus, the study not only established the essentiality of the photobiont for the lichenization but also highlighted the success rate of the lichen cultures. The lichen can be a good candidate for pharmaceutical industries for large scale production of active lichen compounds. Reports on the production of protocetraric acid from bioreactor study of the lichen culture have come in recent past (Behera et al., 2012).

Application of humidity stress by supplementing 4% sucrose was also undertaken which gave satisfactory results in this study as well in case other lichen cultures also. Light period was an important governing factor. Also the culture studies were not successful, as after initiation culture, the thallus did not survived from invading microbial contamination. The failure of lichen whole thallus culture was mainly due to invading endo-mycotic infection. Many studies have come into knowledge for a wide spectrum of antimicrobial activity. The 50% v/v EtOH extract was tested for its antibacterial and antifungal activity in the
present study. The extract was though not reported active against any of the tested bacteria or human pathogenic fungi.

On the whole, lichens were tested for their various biological aspects; such as antibacterial, antifungal and the antioxidant activity and ability to propagate in vitro conditions lichens. Foliose and fruticose lichens; were found with good antibacterial activity with MIC ranging from 0.03 to 2.5 mg/ml. The lichen *U. longissima* was found the best source of antibacterial agent while the Extracts of aforementioned lichens were subjected to antibacterial and antifungal activity. **Percent yield obtained for lichens in decreasing order was Usnea longissima Ach> Roccella montagnei Bel > Parmotrema reticulatum (Taylor) M. Choisy > Cetrelia braunsiana (Mull Arg) Culb. and Culb > Cladonia rangiferina (L) Weber were the high extract yielding biological source.**

The antimicrobial potential of the lichens were in order: *Usnea longissima Ach>*Roccella montagnei Bel >Cetrelia braunsiana (Mull Arg) Culb. and Culb>Parmotrema reticulatum (Taylor) M. Choisy> Cladonia rangiferina (L) Weber against the bacterial pathogens whereas *Roccella montagnei Bel > Cetrelia braunsiana* (Mull Arg) Culb. and Culb> *Parmotrema reticulatum* (Taylor) M. Choisy>*Usnea longissima>Cladonia rangiferina* (L) Weber against the fungal pathogens.

Ultimately, focused attention will be drawn towards production, isolation and characterization of novel compounds from the aposymbiotic and lichenized cultures of the lichens; which on one hand will be helpful in conservation of lichen biodiversity in nature and on the other hand make the product commercially viable.
The culture works have progressed a lot in the coming decade with some of the path-breaking discoveries by many leading lichenologist. In the recent past, with the advent Biodiversity Bill, one should have a sustainable approach, as the scientific people are under constant scrutiny by the Government authorities for their exhaustive exploration of the natural resources and the biodiversity.

Therefore, this study proves the antimicrobial potential of extracts of *R. montagnei*, *U. longissima*, *C. braunsiana*, *C. rangiferina* and *P. reticulatum* and in the discovery of the novel potential biomolecules from lichens, application of different solvents in combination with extraction procedures. Further processing and investigation into fractionation and purification of ethanolic extract may result in the isolation of viable alternate source to the presently available antibiotics. Lichens hold great potential that needs to be fully explored and utilized for the benefit of human health and our society. This will definitely provide a new base and ray of light for the future perspectives and highlight the need for further studies of this promising source to harvest more beneficial in the field of bioprospection. Thus, this work is intended to contribute and help in the current research and development trends in the bioprospection of lichens and their bioactive compounds for the commercial viability after undergoing detailed culturing the study for harvesting the secondary metabolites, indirectly also, contributing towards the conservation of slow growing lichens in nature.