Lichens are complex organisms involved in symbiotic relationship between a phycobiont (Cyanobacteria or Green alga or both) and a mycobiont (a fungus), and have attracted considerable attention because of their perceived position on the ladder of evolution to land plants (Heckman et al., 2001). Both partners undergo balanced and synchronized growth and development. Lichens have a worldwide distribution, occurring in the highest, hottest, coldest, wettest and driest habitats, yet they are extremely sensitive to pollution (Hawksworth and Honegger, 1994; Rai and Bergman, 2002). The dual nature of lichens was first propounded in 1867 by the Swiss botanist Simon Schwender. According to him “the algae are the nutrition-serving slaves of the dominating master, the fungus”. The two become intimately associated and form new plants with individual character. Up to that time they had been regarded as simple organisms intermediate between algae and fungi (Lamb, 1959). It is assumed that symbiotic relationship between the photobiont and mycobiont is obligate; the lichen group is polyphyletic and appeared on the earth at different times during evolution. The first lichens probably developed around 440 million years ago, and preceded even the first plants (Willis and McElwain, 2002). Presence of micro ecosystem is so well balanced that lichens are suited for a wide range of habitat from exclusively aquatic to terrestrial to deserts (Hale, 1983). It has been suggested that lichens are the most obvious candidates to suit the environment in the planet Mars if there is a possibility of life existing there (Neelakandan, 1965).

Lichens can be structures that form flat formations that are appressed to a surface, leafy forms that have attachments to their surface or foliar forms that have a single attachment to a surface with the larger part either erect or hanging from the attachment. The fungus primarily determines the form, but the photobiont may also influence it. Thus, complex forms are possible within lichen.

The simplest form of lichen is a crust on the surface. Crustose lichens are highly variable in anatomy. However, they all tend to be attached directly to their surface. Their growth tends to be radiate, in that the mitotic regions are at the margins, and the center is more likely to be dying.
Foliose lichens have a sheet-like structure, and are attached to their surface by root-like rhizines. The thallus is highly differentiated, with the lower surface being an absorptive tissue and the photobiont being held in a manner that maximizes photosynthesis. Commonly, the upper surface is fungal tissue, with the mid-layer containing the photobiont. Growth takes place at the margins, and these tend to be lobed.

Fruticose or umbilicate lichens are attached to their surface by a holdfast. The main body of the lichen is either erect or pendulous, and commonly highly branched. Growth takes place at the ends of the thallus and may be quite complex.

The majority of fungi integrated in lichen symbiosis belong to ascomycetes; about 20% of all known fungi and 40% of all known ascomycetes are lichenized, and very few basidiolichens (about 20 species). According to literature accounts most of the lichens are ascolichens (Ahmadjian, 1967, 1973).

Literature records species from 34 different chlorophycean genera that have been found in the lichen symbiosis. The genera range from unicellular to heterotrichous forms. The most common phycobionts belong to the genera Trebouxia (Chlorococcales) and Pseudotrebouxia (Chlorosarcinales) (Archibald, 1975; Hildreth and Ahmadjian, 1981). Approximately 10 genera of cyanobacterial (blue–green) phycobionts have been recorded from lichens. They are either single cells or trichome forming species. Only one known phycobiont belongs to Xanthophyceae.

Lichen thallus that associate with cyanobiont as photosynthetic partner provides nutrients to mycobiont and are known as cyanolichens. About all known fungi, only 10% of lichen species are bipartite. Wide ranges of cyanobionts are found in lichen symbiosis. Cyanobacteria belonging to morphologically defined genera namely, Chroococcidiopsis, Chroococcus, Cyanosarcina, Myxosarcina, Entophysalis, Hyella, Calothrix, Dichotheix, Scytonema and Stigonema are found in lichens as primary or secondary phototrophic symbionts (Budel and Henson, 1983). However, the identity and taxonomic affiliation of lichenized green algae and cyanobacteria at species level are less clearly understood than of lichenized fungi because their morphology is modified by interaction with the fungal hyphae, and only some stages of life cycle may be present. Thus cultivation is necessary.
although not necessarily a sufficient requirement for positive identification. Cytological studies have shown many significant differences between *Nostoc* cells in lichens and cells that have been removed into axenic cultivation (Bergman and Hallborn, 1981; Boissiere, 1987). It has been estimated that the photobiont has been determined at the species level in less than 2% of all lichens (Honegger, 1992). Most common forms are *Nostoc*, *Scytonema*, *Calothrix*, *Fischerella* and several unicellular forms are also reported. These include *Gloeocapsa*, *Gloeothecae* and *Synechocystis* (also *Aphanocapsa*) (Rai 1990; Ahamadjian, 1993; Nash 1996; Galun 1988; Rai et al., 2000).

The fungus–alga relation in lichens is an ectotrophic association. In most species with green phycobiont, the components are in simple proximity to one another or with wall-to-wall contact. Haustorial penetration occurs but the percentage of invaded algal cells is small. It appears that fungal penetration in to an algal partner is not an obligatory phenomenon for mutual relationship between the symbionts of lichen (Galun et al., 1971).

Fungal penetration has rarely been observed in the phycobiont *Nostoc*, which is a more common partner of cyanolichens (Bousfield and Peat, 1976). On the other hand, light and electron microscope studies in other cyanolichens have revealed pronounced fungal intrusions in a number of both filamentous and unicellular cyanobionts (Boissiere, 1977; Marton and Galun 1976). The fungus indents the cyanobacterial cell wall causing it to invaginate, usually deep in to the cell and often in to each cell. Both partner's cell walls remain intact, except for the outer sheath of the cyanobacterium, which is no longer apparent.

As a result of symbiotic condition, extra and intracellular substances are synthesized by variety of lichens. The secondary metabolites are heterogeneous and belong to a variety of chemical compounds including fatty acids, aromatic polyketides (depsides, depsidons, dibenzoquinone, etc.) mevalonate group components and shikimate group components (Culberson, 1969; Mosbach, 1973). Over many centuries lichens have been a source of useful medicinal and chemical products. There are amusing legends on the usefulness of lichens (Richardson, 1975). Certain lichen products are still important commodity in the perfume and soap industry, and as dye for textiles.
Cyanobacteria that are originally referred as blue-green algae, a unique group of gram negative, prokaryotic organisms bridging bacteria and algae are very much akin to chloroplast of plants, whose distribution around the world delegated only by bacteria. Particularly, in the last quarter of this century, there has been such an information explosion about these hitherto neglected organisms, that today they seem to be neck to neck with bacteria in biotechnology race, with every promise of over taking them by the turn of the century due to their twin potential of fixing atmospheric carbon and nitrogen (Thajuddin and Subramanian, 2005). In addition they are used as biofertilizers, as an excellent food and feed (Mitsui, 1979; Sheshadri and Thomas, 1979; Venkatraman and Becker, 1985; Subramanian et al., 1994), supplement to fight malnutrition of proteins and vitamins. There are several recent promising reports on their potential applications in medicine (Sundararaman et al., 1996), pharmaceuticals (Gustafson et al., 1989; Becker, 1994), fine chemicals, enzymes, diagnostics, fuel and waste treatment and recycling process (Mitsui, 1978; Subramanian and Prabhakaran, 1994).

Cyanobacteria are an ancient, morphologically diverse group of prokaryotes with an oxygenic photosynthesis. Many cyanobacteria also possess the ability to fix atmospheric N₂, although well suited to an independent existence in nature. Some cyanobacteria occur in symbiosis with a wide range of hosts (protists, animals, and plants) (Rai et al., 2000). With these N₂ fixing symbiosis involving heterocystous cyanobacteria particularly Nostoc as cyanobiont, a given host species associates with only a particular cyanobiont genus and specifically does not extend to the strain level. The cyanobiont is located under micro aerobic environment in a variety of host organs and tissues (bladder, thalli and cephalodia in fungi; cavities in gametophytes of horn worts and liver worts or fronds of the Azolla sporophyte, coralloid roots in cycads; stem glands in Gunnera).

The photosynthesizing and N₂ fixing cyanobacterial genus Nostoc participates in a wide range of symbiotic association with host from different organisms group. It is clear that the other partners gains either photosynthate or combined nitrogen from associating with Nostoc. The sequences for Nostoc to participate in these associations are not obvious.

The dualistic nature of the lichen thallus was known for more than 100 years ago. But lichenologists all through the period have concentrated their
attention only on the mycobiont, while the algal partner received the least attention. This is especially true of the taxonomic study of lichen phycobionts (Tschermak-Woehs, 1988). At world level, the photobionts have been identified up to species level, only at 2% of known lichens. As far as Indian lichens are concerned photobionts have not been identified up to species level not even in one case (Hariharan, 1991). Genus level identification has been done for about 10–15% of world lichens, however not even 1% of Indian lichens were identified at genus level. One way to circumvent such impediments is to use methods that target taxonomically or phylogenetically informative macromolecules of the photobiont directly from the lichens. Molecular approaches remove the requirement for axenic cultivation of the organisms and can be designed to provide access to a particular genome with in an association of symbionts. Information generated by the Polymerase Chain Reaction (PCR) using cyanobacteria-specific primers for genetic markers such as 16S rRNA genes of cyanobacteria has been used to great advantage in studies of symbiotic photobionts in lichens (Miao et al., 1997; Nubel et al., 1997; Lohtander et al., 2003). Modern DNA based typing methods such as Randomly Amplified Polymorphic DNA (RAPD), Short Tandemly Repeated Repetitive (STRR) sequences and Repetitive Element PCR (REP-PCR) are simple PCR based methods that were successfully employed for the species and strain level variations of cyanobacteria. So based on this analysis, the present investigation focused on lichen diversity, symbiotic cyanobacteria in lichen and molecular characterization of symbiotic cyanobiont in cyanolichens.

Studies on morphology, physiology, biochemistry, molecular biology of symbiotic cyanobacteria in lichens are very meagre. In India, investigations concerned with biodiversity of cyanobacterial symbionts in cyanolichens with reference to isolation, cultivation, morphological, biochemical and molecular characterization were not so far undertaken. Pioneer workers from different part of world such as Budel (1985); Budel and Rhiel (1987); Kardish et al. (1990); Lange et al. (1993); Wasthuber and Loos (1996); Nubel et al. (1997); Miao et al. (1997); Paulsrud and Lindbald, (1998); Goward and Arsenault (2000); Schultz et al. (2000a); Lothander et al. (2003); O'Brien et al. (2005), were studied the morphological and molecular characterization of cyanobacterial symbionts in cyanolichens.
The present study is aimed to assess the biodiversity and distribution of lichens including cyanolichens from Yerkaud (Shervaroy hills) Salem, and Kollihills (Kollimalai), Namakkal of Tamil Nadu, India. Further isolation of cyanobiont from the cyanolichen such as *Collema auriforme* (With.) Coppins & Laundon., *Collema rugosum* Krempelh, and *Leptogium milligranum* Sierk were also carried out. The main objectives of the present study as follows:

1. Biodiversity and distribution of lichens of Yerkaud and Kollihills of Tamil Nadu.
2. Isolation and identification of epiphytic and symbiotic cyanobacterial association in lichens.
3. Physiological and biochemical characterization of symbiotic cyanobacteria isolated from the lichen (*Collema auriforme* (With.) Coppins & Laundon., *Leptogium milligranum* Sierk, and *Collema rugosum* K. rempelh)
5. Fatty acid profiles study of three symbiotic cyanobacterial isolates.
6. Molecular characterization namely 16S rRNA amplification and sequencing, secondary structure prediction and RFLP analysis of 16S rRNA genes and RAPD studies were carried out for the symbiotic cyanobacterial isolates (*Aphanocapsa* sp. (NTK28), *Nostoc* sp. (NTK28) and *Nostoc* sp. (NTY30) to understand their taxonomy and phylogeny.