SUMMARY

The lichenological investigation incorporation in this thesis initiated under the joint supervision of Prof. J. Rout, Professor, Assam University Silchar and Dr. D. K. Upreti, Scientist and Head, Lichenology Laboratory, National Botanical research Institute, Lucknow. The present study has been designed for conducting floristic exploration, taxonomic studies, ecological studies of the lichen growing in different parts of Cachar district and pollution monitoring studies with the help of lichen transplant technique in the polluted area of Cachar district of Assam.
The study area has been thoroughly surveyed and the sampling points have been selected on the basis of a particular host tree which is available in all the sampling points. *Areca catechu* is selected as an ideal host tree for the collection of lichens as it is found both in urban and rural areas of the district. Detailed works on the ecological and taxonomical aspects of lichens have been carried out during the study. After survey, the district has been divided into five zones representing the different pollution level and ecological conditions and designated as Central zone, East zone, West zone, North zone and South Zone. The Central zone is considered as polluted zone as compared to other four zones. The zones are again sub divided into 20 sites to carried out the ecological studies. For the collection of lichen specimens and recording the ecological data, all the study area of Cachar district were frequently surveyed in the year 2007-2009. The lichen specimens were collected from the *Areca catechu* tree growing in the study area. The specimens were removed from the tree bark by using a hammer and sharp knife or a chisel.

At the time of collection the details of locality, altitude, were also recorded. In the laboratory the specimens brought from the field were sorted out and the specimens separated from the bark were fixed in a hard paper with glue and dried properly. The specimens were placed in herbarium packets of 17 x 10 cm size, with the details of locality, collection date, field number, collector name and other ecological notes. The labeled and dried specimens were identified by studying their morphology, anatomy and chemistry. The recent literature of Awasthi (1988, 1991, 2000), Upreti (1984, 1988), Divakar (2001), Nayaka
Singh & Sinha (2010) was consulted for identification of the lichen taxa. The external morphology has invariably been studied under dissecting binocular microscope. The anatomy of the thallus and apothecia were studied under compound microscope.

Colour test has been performed by chemical reagents, 5% potassium hydroxide (K), aqueous solution of Calcium hypochlorite (C), Paraphenylenediamine (PD), Iodine (I) and aqueous solution of nitric acid by applying it on thallus and medulla which shows the changes in colour. The Thin Layer Chromatography (TLC) for identification of secondary metabolites was performed followed by the techniques of Culberson (1972), Walker and James (1980) and white and James (1985). The presence of certain lichen substances was also indicated when the lichen thallus containing them were exposed and observed under 254 nm or 366 nm UV light.

The following diversity indices has been used to assess species diversity viz. 1) Margalef’s index 2) Menhinick’s index 3) Evenness 4) Simpson index 5) Shannon-Weiner index and Beta diversity (Jaccard, Sorensen and Whittaker measures of similarity). Apart from taxonomical and ecological studies, the physiological parameters such as Chlorophyll content, Chlorophyll degradation, Carotenoid, bark pH and water holding capacity were also studied.

Metal accumulation by using transplanted lichens were carried out in the eight polluted sites of Silchar town with two vertical height. Vehicles (diesel and
petrol) per minute in the transplanted area also studied to see the vehicular emissions.

The study reveals the occurrence of 71 species belonging to 32 genera and 15 families. Among the three growth forms only two growth forms were detected throughout the study area. The present floristic studies carried out on a single host tree, *Areca catechu* of Cachar district of Assam revealed 5 species (*Graphis striatula*, *Phaeographis lobata*, *Phaeographis subtigrina*, *Lecanactis patellarioides* and *Antracothecium globiferum*) belonging to 5 genera and 3 families (Graphidaceae, Roccelaceae and Pyrenulaceae) are reported new for India. *Tetromelos* is the new genera for India reported from the study area for the first time. The Eastern Himalayan region is the richest lichen diversity in the country (Singh, 1999). Interestingly, though the study indicated as many as 31, 30 and 16 lichen species that were reported for the first time from Southern Assam, Assam and North East region respectively. *Areca catechu* as host plant was, however, not included in this or any previous studies. There are 14 endemic species detected in this study and they are *Arthonia inconspicua*, *Arthothelium confertum*, *Arthothelium chiodectoides*, *Diorygma megasporum*, *Graphis capillacea*, *Hemithecium apaneomicrosporum*, *Buellia morehensis*, *Pyxine austroindica*, *Pyrenula introducta*, *Anthracothecium cristatellum*, *Trypethelium albopruinosum*, *Trypethelium assimile*, *Trypethelium endosulphureum* and *Trypethelium indicum*. As compared to Indian endemic lichen species the highest endemic species contributor in terms of genera is the *Pyxine* (25%) which is followed by *Trypethelium* (17%), *Arthonia* (14%), *Anthracothecium* (13%). In
the study Graphis has the highest species diversity but lowest in endemic species contributor with 3%. Extensive study covering Areca catechu trees and different host trees from other areas of the district are likely to afford more new species, genera and the family too. The crustose form dominates the area with 58 species, followed by 13 species of foliose lichens. The fruticose form of lichens is not recorded in the study area. The members of Graphidaceae family exhibit their dominance in the area represented by 25 species followed by 8 species of Caliciaciaceae, 7 of Arthoniaceae and Pyrenulaceae, Trypetheliaceae and Parmeliaceae with 5 species. There were 15 genera and 7 families of lichens represented by single species each. It is notable that the ten dominant families of India, Graphidaceae has the highest species contributor represented by 8.79% of the total Indian Graphidaceous flora followed by 8.25% of Caliciaceae and 7.59% Trypetheliaceae family. Similarly at the Generic level, the Genus Graphis shows maximum diversity represented by 8.11% of the total Indian Graphis species diversity. Out of the three major growth forms, only two growth forms are observed in the district with 82% of crustose and 18% of foliose lichens. As according to zone wise, all the five zones are dominated by crustose growth forms with over 82% in Northern zone, 81% each in Eastern and Southern zone, 70 % in Western zone and the 56% in Central zone. Growth forms of lichens indicate the air quality of that particular area. It is believed that the foliose growth forms are more sensitive to poor air quality as compared to the crustose growth forms. Interestingly the Graphidaceae family has been able to be the most successful in adapting in all the five zones in terms of its dominance. The species
rich zones are also rich in terms of families and in terms of genera. The Eastern Himalayan foothills have moist, damp climate suitable for the growth of many Graphidaceous and Pyrenocarpous lichens and a number of foliose and follicolous lichens (Upreti, 2001). As lichens are capable of indicating the microclimatic changes of their habitat the present enumeration of lichens in the area will constitute a baseline record for conducting future environmental biomonitoring studies.

Depending on the ecological data available, the area having maximum disturbance (Central zone) due to heavy traffic and vehicular exhaust and other zones having lower disturbance due to outskirts of the town. Central zone has lowest species diversity, species richness and similarity measures while the species diversity and richness is highest in east zone followed by north and south. A comparative account of different ecological parameters studied in different zones clearly indicates that lichen communities were maximum in areas where less human interference or less polluted area. *Dirinaria aegialita* is the most luxuriantly growing species in the region and used it as lichen species for transplantation in the polluted area.

Various physiological parameters shows significant correlation of chl.a with chl.b and carotenoid content while chlorophyll degradation had negative correlation with chl.a, chl. b, total chlorophyll and carotenoid content. Correlation between the metallic pollutants and some physiological parameters of transplanted lichens, which represents the metallic pollutants on the metabolic process of the species. The high correlation of total chlorophyll content with chlorophyll a, chlorophyll
Chlorophyll $a$, chlorophyll $b$ and total chlorophyll shows negative correlation with Fe while chlorophyll degradation shows positive correlation with Fe. Pb shows negative correlation with chlorophyll $a$ and carotenoid. The possible source of element may be indicated by significant correlation between elements in the lichen thallus. *Dirinaria aegialita* accumulates high amount of Fe than other elements within a short exposure time period of one month during study. Hg was detected in very low amount in the transplant area as compared to other elements. All the transplanted sites exhibit average amount of elements except in the control site. Control site has lower accumulation of elements than the transplanted site. All the sites exhibit similar sequence of metals as Fe > Pb > Hg. Among the three metals analysed, Fe seems to cause damage to the biological apparatus by causing alteration in the vital physiological process like chlorophyll content, carotenoid.

The available account of the lichen flora from the study area will be utilized in future for preparation of monographs on the Indian lichens. The policy makers, foresters, conservators, silviculturist and land managers can use the data in developing conservation and management strategies regarding the areas in Cachar district of Assam.