ABSTRACT

Diversity studies play an important role in the floral wealth of the state as well as the country. Lichen is a symbiotic association of two organisms, an alga and a fungus. Lichens are composite thallophyte of which 90% of the thallus is predominated by mycobiont and it provides shape, structure, colour to the thallus. Lichen constitute about 8% of earth's surface. North-Eastern states of India is a part of the Indian Himalayan biodiversity hotspot and truly represents one of the biodiversity rich regions in the world, a paradise. The region has always been a focus of distinctive courtesy to the plant explorers and nature lovers. The present study was carried out in the district Dhubri of Assam, situated in the extreme western part of Assam and is a gateway to North-East India. The district is bounded by both inter-state and international border i.e. West Bengal and Bangladesh in the west, Goalpara and Bogaigoan district of Assam in the east, Kokrajhar district in the north, South Salmara–Mankachar district and state of Meghalaya in the south. It covers an area of 2,176 sq. km and includes rivers and hillocks. Approximately 2000 epiphytic lichen specimens were collected. All the specimens were deposited in the Bodoland University Botanical Herbarium (BUBH), Department of Botany, Bodoland University, Kokrajhar, Assam, and India. A set of voucher specimens of some of the species were deposited in the 'National Repository' of CSIR-National Botanical Research Institute (LWG), Lucknow, India. Identification of lichen samples involve examination of external morphology, anatomical observations and identification of chemical substances present in the lichen thallus. Quantitative ecological parameters for identified lichen species were used for describing the community structure. A total of 196 lichen species under 18 families and 36 genera were recorded from the district. Out of 196 species 28 species are new record to Assam viz. *Allographa stictilabiata* (Patw. & C.R. Kulk.) J. Kalb & Kalb; *Bacidia personata* Malme; *Clathroporina mastoidea* (Ach.) R. C. Harris; *Diorygma reniforme* (Fée) Kalb, Staiger & Elix; *Graphis analoga* Nyl.*; G. argentia* Makhija & Adaw.; *G. asahinae* Patw. & C.R. Kulk.; *G. bakeri* Vain.; *G. consimilis* Vain.; *G. eburnea* Adaw. & Makhija*; G. modesta* Zahlbr.**;** *G. nematoides* Leight.; *Herpothallon himalayanum* Jagad. Ram & G.P. Sinha; *Phaeographis manipurensis* Müll. Arg.; *Lecanora insignis* Degel.; *L. leproplaca* Zahlbr.; *Lepraria incana* (L.) Ach.*; Physcia abuensis* D.D. Awasthi & S. R. Singh*; P. aipolia* (Ehrh. Ex Humb.) Fürnr.*; P. alba* (Fée); *P. lamprocarpa* Müll. Arg.; *P. mastophora* (Nyl.) Müll. Arg.; *P. minor* Fée; *P. welwitschii* (Upreti & Ajay Singh) Aptroot*; Pyxine isidiophora* (Müll. Arg.) Imshaug; *P. effilata* Brand & Sérus.; *Stirtonia*

macrocarpa Makhija & Patw. and *Viridothelium virens* (Tuck & Michener) Lücking, M.P. Nelsen & Aptroot; 15 species are new record to India viz. *Allographa fujianensis* (Z. F. Jia & J. C. Wei) Lücking & Kalb; *Arthonia fissurinella* Nyl.; *Coenogonium bacilliferum* (Malme) Lücking, Aptroot & Sipman; *C. pineti* (Ach.) Lücking & Lumbsch; *C. subdilutum* (Malme) Kalb; *C. wrightii* (Vězda) H. Harada & Lumbsch; *Diorygma roseopruinatum* Popong, Lücking & Parnmen; *Graphis arbusculaeformis* (Vain.) Lücking**;** *G. dracaenae* Vain.; *G. emersa* Müll. Arg.*; G. enteroleuca* (Ach.) Lücking; *G. immersicans* A.W. Archer; *G. litoralis* Lücking, Sipman & Chaves; *G. luluensis* A. W. Archer and *Pyrenula chlorospila* Arnold**;** 15 species are endemic to Indian regions viz. *Allographa stictilabiata* (Patw. & C.R. Kulk.) J. Kalb & Kalb; *Arthonia recedens* Stirt.; *Arthothelium confertum* (A.L. Smith) Makh. & Patw.; *Arthopyrenia subvelata* (Nyl.) R. C. Harris; *Cryptothecia verruculifera* Jagad. Ram, G.P. Sinha & Kr. P. Singh; *Herpothallon himalayanum* Jagad. Ram & G.P. Sinha; *Glyphis duriuscula* Stirt.; *Graphis ajarekarii* Patw. & C.R. Kulk.; *G. argentia* Makhija & Adaw.; *G. coarctata* Stirt.; *G. distincta* Makhija & Adaw.*; Phaeographis manipurensis* Müll. Arg.; *Physcia abuensis* D.D. Awasthi & S. R. Singh; *Pyrenula mastophoriza* (Nyl.) Zahlbr. and *P. subacutalis* Upreti. Therefore this will help to understand the lichen diversity better and give the correct status of the state. Majority of the lichens were crustose (88%) followed by foliose (11%) and leprose (1%). Fruticose lichens were not encountered during the study. Among the families Graphidaceae were the most dominant followed by Pyrenulaceae and among the genera, *Graphis* and *Pyrenula* were the most dominant. The frequency of *Dirinaria applanata*, *D. consimilis*, *D. picta*, *Lecanora helva* and *Pyxine cocoes* was 100% and other species frequency ranges from 14.28-85.71%. Abundance of the species *Pyxine cocoes* (10.85) was maximum followed by *P. reticulata* (5.00), *Lecanora helva* (4.85), *Parmotrema saccatilobum* (4.00) and *Dirinaria applanata* (4.00). Other species ranges from 1-3.16.

Lichen species are rich in their secondary metabolites for which they are used for bioprospection studies. Secondary metabolites of lichen are also known as lichen substances which are unique to lichen species and have very important medicinal properties. Based on the availability of lichen samples in the study area and their chemical constituents seven macrolichens viz. *Dirinaria applanata* (Fée) D.D. Awasthi, *D. consimilis* (Stirt.) D.D. Awasthi, *D. papillulifera* (Nyl.) D.D. Awasthi, *D. picta* (Sw.) Clem. & Shaer, *Pyxine cocoes* (Sw.) Nyl., *P. reticulata* (Vain.) Vain. and *Parmotrema saccatilobum* (Taylor) Hale were considered for phytochemical and antimicrobial

studies. Methanolic and hexane solvents were used for extraction of secondary compounds. Preliminary phytochemical analysis revealed the presence of alkaloid, flavonoid, phenolic compounds, tannin and triterpenoids whereas saponin was absent in both of the extracts. Presence of the above mentioned compounds have very potent antimicrobial property. Highest phenolic content was found in methanolic extract of *D. picta* (112.33±0.13 mg GAE g^{-1}DW) followed by *D. papillulifera* (73.84±3.19 mg GAE g^{-1}DW) and highest flavonoid content was found in methanolic extract of *D. papillulifera* (26.54±0.67 mg QE g^{-1}DW) followed by *D. picta* (21.23±1.35 mg QE g^{-1}DW).

For antimicrobial activity, *Pyricularia oryzae* (MTCC 1477), *Xanthomonas oryzae* (MTCC 11102), *Colletotrichum gloesporoides* (MTCC 10529) and *Sclerotonia slerotium* (MTCC 8785). were considered. This study revealed that methanolic extract of *D. picta* showed potential antimicrobial activity against phytopathogens of Rice and Jute crop plants viz. *Pyricularia oryzae* and *Colletotrichum gloesporoides*. The extracts were effective in inhibiting the mycelial growth of phytopathogenic fungi and the vulnerability to the extract was in the order: *P. oryzae* > *C. gloesporoides* > *X. oryzae* > S. *slerotium*. The Minimal inhibitory concentrations and IC50 values of the tested foliose lichens against tested phytopathogens. The MIC values of the methanolic extracts were lower than that of hexane extracts. In future further research on secondary metabolites of *D. picta* could lead to use the lichen as a potent biological control measurement as fungiside.

Keywords: Lichen Biodiversity, North-East India, Endemic, New records, Phytochemical screening, Phytopathogens, Antimicrobial screening.