International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Lichen Diversity in Sillery Gaon, Kalimpong, Wb, India

S. Majumder[1], S.N. Sinha[2]

[1,2]Environmental Microbiology Research Laboratory, Department of Botany, University of Kalyani, West Bengal, India.

Abstract:
Lichen is a brilliant illustration of symbiotic relationship. They found in all imaginable atmosphere. In this present study we recorded 10 lichen species belonging to 7 genera and 3 families are collected from a tiny village, Sillery Gaon, Kalimpong, WB. Among the 10 species documented, we found that the foliose natures of lichen dominated having 6 species over the crustose and fruticose natures . From the present study spot no earlier information is there. Still now this is the earliest report on the lichens of Sillery Gaon. Thus there remains a adequately chance for further more additional studies. Our work will aid us to recognize the exact status on lichen diversity of our state.

Keywords: Lichen diversity, West Bengal, Kalimpong, Sillery Goun.

INTRODUCTION:

An almost unexplored Sillery Gaon, a small village in Kalingpong District of West Bengal, is extremely diverse with it's pictographic view. The name Sillery arises from a name of plant i.e. 'Celery' which propagates very commonly in this area. This tiny hamlet holds a very few inhabitants of around 30 families. This village having it's surprising sight and natural attractive enchanting beauty of Kanchenjunga is also called as the "New Darjeeling". Having dense stunning forest and attractive views, Sillery Gaon is very much decorated by the nature. Among the plant flora, lichens are also create a imperative part of it's vegertation. They are the most fruitful and abundant symbiotic relationship in nature where two unrelated organisms are involved. Among them the fungal member plays the key role by arranging the house for the alga and the alga having chlorophyll makes food through photosynthesis (1). Lichens grows in any environmental condition and on any surface. The lichen displays differences in its morphology and classified mainly into 3 groups Such as lichens which develops across the substratum called crustose lichen form; lichens which are leafy and bound loosely called foliose lichen form; and the lichens which have pendant or upright and shrubby or bushy growth called fruiticose lichen form. Because of its unique and amazing characters, they comes as a pioneer in a bare land. Though they have very significant characters but they obtain a very pintsize scientific attention with compare to other group of plants. From a very ancient period Lichens are used in folk medicines providing an alternative treatments and play a significant role in human wellbeing (2). They are the significant impending sources of natural unique bioactive compounds which plays role in various pharmaceutical and phytochemical uses (3; 4).

MATERIALS AND METHOD

Study site

The average altitude of Sillery Gaon is 6000ft and the latitude of Sillery Gaon is 27.1396^0 N and longitude is 88.5804^{0}E. The position of Sillery Gaon in Kalimpong hills is exclusive as it is surrounded by Sikkim (East &North), Nepal on its Western side and Bengal is situated on South side . The temperature fluctuates in Sillery Gaon from 15-25^{0}C in summer to 2-16^{0}C in Winter. And it have71-91% humidity level. Due to have such appropriate climatic circumstances lichens grows here abundantly.

Field Survey and Collection

More than 10 lichen specimens are collected from the dense forest of the hamlet during the field trip which is organized on 10.5.19 for the lichen specimen collection.

Identification

From all the obtainable spaces (such as Trunk, Twig, Leaf etc.) the samples were taken. After the collection the specimens were dried properly and then studied morphologically (i.e. forms, size, structure etc.) , anatomically (i.e. cellular structutre) and chemically(by color spot tests) (5). This tests were implemented by different chemicals such as K test(reagent : 5% KOH), C test (reagent : $Ca(ClO)_2$) and P test (reagent : PPD)(6).

RESULTS AND DISCUSSION

The plentiful and treasured lichen vegetation of Sillery Gaon is of tropical type and narrowed mostly on trees. Due to the dense growth of different plants this study site provide a appropriate atmosphere for colonizing several types of lichens on several types of substratum (Table 1). Their most important therapeutic and additional usages are also denoted in Table 2. Also the morphological characters of studied lichen species are represented in Table 2. And here we also prepare an easy and useful indetifing Key to recognize the collected specimen.

Table 1. Enumeration of lichen flora collected from Sillery Gaon.

SL No.	Lichen Name	Family	Habit (Thallus type)	Habitat (Based on substrate)
1	***Parmotrema austrosinense*** (Zahlbr.) Hale	Parmeliaceae	Foliose	corticolous
2	***Parmotrema sancti-angeli*** (Lynge) Hale	,,	,,	,,
3	***P. tinctorum*** (Nyl.) Hale	,,	,,	,,
4	***Flavoparmelia caperata*** (L.) Hale	,,	,,	,,
5	***Parmelia sulcata*** Taylor	,,	,,	,,
6	***Evernia prunastri*** (L.) Ach.	,,	Fruticose	,,
7	***Usnea florida*** (L.) F. H. Wigg.	,,	,,	,,
8	***U. filipendula*** Stirt.	,,	,,	,,
9	***Physcia aipolia*** (Ehrh. Ex Humb.) Furnr.	Physciaceae	Foliose	,,
10	***Graphis scripta*** (L.) Ach.	Graphidaceae	Crustose	,,

Table 2. Crucial information (morphological & chemical) about the lichens and their importance.

SL No.	Lichen Name	Spot Test	Secondary metabolites	Importance
1	***Parmotrema austrosinense*** (Zahlbr.) Hale	K+ yellow, C-, KC-, P-.	Atranorin, Lecanoric acid.	i) It showes a strong antioxidant and antimicrobial activity[8]. ii)In Maharashtra it is sold in Market as Spice [5].
2	***Parmotrema sancti-angeli*** (Lynge) Hale.	K+ yellow, KC+ red, P-, UV-.	Atranorin.	i)In Madhya Pradesh, India people use it to treat skin disease [10]. ii)In Madhya Pradesh, and Karnataka, it is used as Spice[5].
3	***P. tinctorum*** (Nyl.) Hale.	K+ yellow, C- , KC- , P- .	Lecanoric acid, Atranorin, Orsellinic acid, Chloroatranorin.	i)It used as pollution indicator. In a nonpolluted area it displays lobule formation in thallus but in case of polluted area it does not form any lobule [11]. ii) It shows antiproliferative and antibacterial activity[12, 13].
4	***Flavoparmelia caperata*** (L.) Hale.	K-, C-, KC+ yellow, P-.	Usnic acid, Caperatic acid, Atranorin, Porotocetraric acid.	i)In Russia it is used to treat wounds[14]. ii) In northern Mexico this lichen powder applied upon burns [15]. iii) It also have antibacterial activity [4,16&17].
5	***Parmelia sulcata*** Taylor.	K+ yellow, C- , KC- , P+ yellow.	Atranorin, chloroatranorin, Salazinic acid.	i)This species used to make red color dyes [18]. ii)In North America indigenous people used this lichen medicinally[19]. iii)This lichen extracts shows antimicrobial and antioxidant activity[20].
6	***Evernia prunastri*** (L.) Ach.	K-, C-, KC+ yellow,P-, UV- .	Usnic acids, Atranorin and chloroatranorin.	i)Used in perfumery[21]. ii)It contains a starchy edible substance[21].

				iii)A mixture of acids with lichen extracts used to treat infections and external wounds[21]. iv)Methanol lichen extracts shows a wide range of antimicrobial activity[22].
7	***Usnea florida*** (L.) F. H. Wigg.	K+yellow, C- , KC- , P+ orange.	Salazinic acid and Norstictic acid.	i)It have medicinal and also antimicrobial properties. [23].
8	***U. filipendula*** Stirt.	K+ red, KC- , C- and P+ yellow.	Salazinic acid and Usnic acid.	i)It uses as gauze and antibiotic to treat surface wounds[24]. ii) In some part of America *Usnea* used in respiratory and urinary tract infections as a herbal drug [24].
9	***Physcia aipolina*** (Ehrh. Ex Humb.) Furnr.	K+ yellow, C- , KC- , P+ yellow.	Atranorin , Zeorin.	i)Atranorin shows a strong antimicrobial activity against a wide range of bacteria[25].
10	***Graphis scripta*** (L.) Ach.	K- , C- , KC-, P-.	Not known.	i)It have antibacterial activity against some gram positive bacteria[26].

Descriptions :

1. *Parmotrema austrosinense* (Zahlbr.) Hale.

Thallus : Foliose types of growth forms, 8-10cm in diam., irregularly lobed, lobes elongate, apices round.
Upper surface : Gray in colour, smooth and shiny, nonisidiate, nonpustulate ; Soredia present, granular, marginal.
Medulla: with uninterrupted algal layer and whitish in colour.
Lower surface : dark black in colour, rhizinate; Rhizines simple.
Apothecia : rarely found; disc brown; ascospores are elliptical ; Pycnidia are not found.

2. *P. sancti-angeli* (Lynge) Hale.

Thallus : Foliose types of growth forms, green in colour , membranous , loosely adnate, 5-10 cm broadly lobate; lobes are branched.
Upper surface : Rough; apices subconcave; margin crenate; nonpustulates and nonisidiate; soralia whitish, liner and continuous.
Medulla : white in colour.
Lower surface : black in colour, slightly rough, margins dark , smooth; rhizines simple and black.

Apothecia : absent in thallus; Pycnidia : present, marginal; conidia : present.

3. *P. tinctorum* (Nyl.) Hale.

Thallus : Foliose types of growth form, leathery, 20-30 cm wide, irregularly lobed, lobes elongate; apices globular, ciliate.
Upper surface : gray in colour, flat, densely isidiate; isidia simple to branched; nonsorediate.
Medulla : whitish with uninterrupted algal layer.
Lower surface : Black in colour, rhizine present; rhizines are simple.
Apothecia : rarely found and disc brown in colour, ascospores are elliptical; Pycnidia : rarely found and punctiform; conidia present, filiform in nature.

4. *Flavoparmelia caperata* (L.) Hale

Thallus : foliose growth forms, 15-20cm in diam, unevenly lobate; lobes convex, apics round, eciliate.
Upper surface : whitish-yellow , plane , crumpled at age, shiny; soredia present, granular; nonisidiate.
Medulla whitish with uninterrupted algal layer.
Lower surface : black in colour; rhizens present, simple.
Apothecia : rarely found, sessile; disc mainly brown coloured, margin sorediate; asci raise, 8-ascospored; spores simple, elliptical, hyaline; Pycnidia : present, laminal; conidia : present, bifusiform.

5. ***Parmelia sulcata*** Taylor.

Thallus : foliose forms, slightly adnate, lobate; lobes slightly linear, imbricate, 2-5 mm wide.
Upper surface : soft gray, flat, glossy; soredia present, coarse, laminal; nonisidiate.
Medulla : with uninterrupted algal layer, whitish in colour.
Lower surface : black, compact rhizin present; rhizines simple.
Apothecia : rarely laminal apothecia found; margins are sorediate; disc are brown in colour; asci clavate shaped, 8-ascospored; spores elliptical; Pycnidia : rarely found; conidia : commonly present.

6. ***Evernia prunastri*** (L.) Ach.

Thallus : fruticose growth forms, upright, sub pendent, 2-5 cm lengthy; acute axil, ‘V’ shaped from right viewpoint, branched; branches band-shaped, sometimes pointed, often forked, dorsiventral.
Upper surface : yellow, slightly rough; soredia present, granular;
Medulla : whitish with loose algal layer.
Lower surface : Cream coloured, channeled.
Apothecia : bowl-shaped, marginal, stipitate; disc redishbrown; margine usually crenate; paraphyses thread like, unbranched; spores ellipsoid; Pycnidia : rarely found; ostioles dark; conidia present, straight.

7. ***Usnea florida*** (L.) F. H. Wigg.

Thallus : fruticose forms, shrubby in nature, pendant, 4-10 cm lengthy; branches ends with discs which produces spores; dichotomously branched, divergent; black at the base; branches are cylindrical.
Upper surface : numerous papillae are present, cylindrical, dense; isidiate; cortex dull and thick.
Medulla : thin layer and compact algal layer.
Apothecia : sometime lateral or sometime terminal; ascospores elliptical.

8. ***U. filipendula*** Stirt.

Thallus : fruticose forms, greenish, pendulous, 10-20cm long, various branches are hanging from the tree trunk, base of the main stem is black, main branches are few arise at base and then grows vertically, short; fibrils grows horizontally from the main branches and look like fish-bone.
Upper surface : Papilla present and isidia also present especially near the base.

Apothecia : absent.

9. ***Physcia aipolina*** (Ehrh. Ex Humb.) Furnr.

Thallus : foliose forms, rosette, 10-12 cm wide, lobate(1-2mm diam).

Upper surface : clearly flacked having white spots, whitish green; nonisidiate and nonsorediate .

Medulla : whitish.

Lower surface : whitish to pale black.

Apothecia : rich; disc whitish; ascospores brownish; Pycnidia : very common; conidia present, cylindrical.

10. ***Graphis scripta*** (L.) Ach.

Thallus : crustose growth forms, somewhat rough, whitish.

Apothecia : elevated; disc constricted to wide, open, mainly curved but sometime forked with raised dark margins and a grey hymenium; ascospores are hyaline; Pycnidia : present, immersed; bacilliform conidia also present.

Fig 1: Different Lichen species collected from Sillery Goun.

1. ***Parmotrema austrosinense,*** **2.** ***P. sancti-angeli,*** **3.** ***P. tinctorum*** **4.** ***Flavoparmelia caperata*** **5.** ***Parmelia sulcata*** **6.** ***Evernia prunastri*** **7.** ***Usnea florida*** **8.** ***U. filipendula*** **9.** ***Physcia aipolia*** **10.** ***Graphis scripta***

Key to the species for Identifying the Lichen specimen from Sillery Goun.

1.Thallus is crust like which attached strongly with the substrate i.e. Crustose type, apothecia elevated, disc constricted to wide, open, mainly curved but sometime forked with raised dark margins and a grey hymenium a thin smooth, therefore it looks like a writing or script…….…… ***Graphis scripta***

1.Thallus is rather than crustose type.

2. Fruticose forms of lichen thallus.

3.Thallus is bushy, the main stem have a running cord through it's centre.

4.Thallus is erect, branches ends with discs which produces spores surrounded by finger like outgrowths and looks like an image of a flower or the Sun. ……..……..……***Usnea florida***

4.Thallus is pendulous, various branches are hanging from the tree trunk, base of the main stem is black, main branches are few arise at base and then grows vertically, fibrils grows horizontally from the main branches and resembling to a bone of fish…….…….. ***U. filipendula***

3.Thallus is branched and parallel to substrate, ribbon shaped, profusely branched thus looks like deer horns ……..***Evernia prunastri***

2.Thallus is leafy and loosely attached to the substrate i.e. Foliose type of growth form.

5.Thallus is nonsorediate and nonisidiate; fruiting body present, apothecia abundant, whitie but blackish brown at centre…….***Physcia aipolina***

5.If isidia or soredia is present on thallus.

6. soredia present, medulla white

7.Upper surface whitish-yellow, crumpled at age ……..……..***Flavoparmelia caperata***

7.Upper surface soft gray, glossy …….***Parmelia sulcata***

8. Marginal cilia absent.……..……***Parmotrema austrosinense***

8. Cilia present, Marginal…… ……***P. santi-angeli***

6. isidia present in cortex; upper cortex gray in colour, flat, isidia simple to branched; nonsorediate……...…… ***P. tinctorum***

The recent work illuminates that 10 lichen species belongs to 7 genera and 3 families collected from Sillery Gaon (Table 3). Among the 10 lichen species noted, the foliose types are dominated having 58% species, followed by fruticose (29%) and crustose (13%) growth forms (Table4). We found that *Parmotrema* genus is dominant with 3 species (Fig 2) over the other genus. On the basis of lichen's growth forms here we found that the crustose types are uncommon (Table 5).

Table 3: Taxonomic analysis of collected lichen specimen.

Family No.	Genus No.	Species No.
3	7	10

Table 4. Habit analysis of collected lichen specimen.

Foliose	Fruticose	Crustose
6 (58%)	3 (29%)	1 (13%)

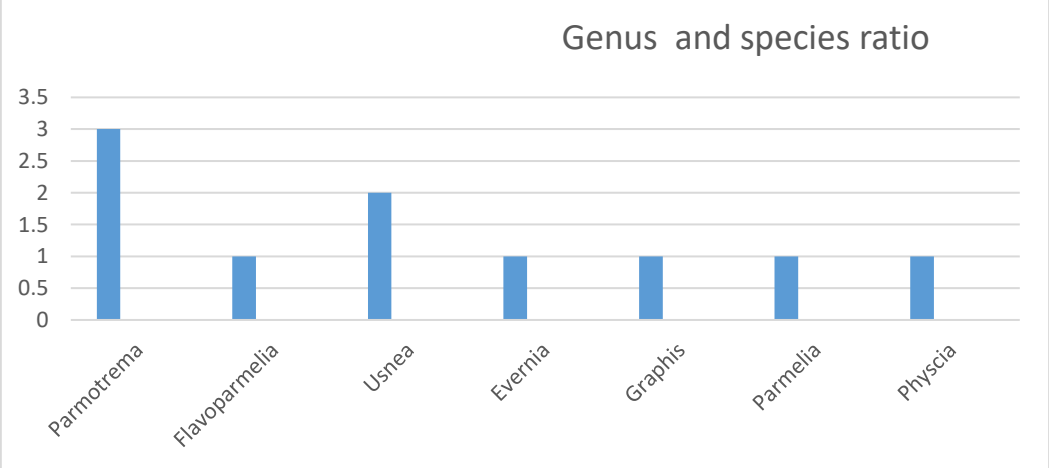

Fig 2: Analysis of Genus and Species ratio.

Table 5. Analysis of Habit of collected lichens.

Family Names	Foliose growth form	Fruticose growth form	Crustose growth form
Parmeliaceae	5	3	0
Graphidaceae	0	0	1
Physciaceae	1	0	0

CONCLUSION

Lichen plays a key role in our ecosystem. The current study discloses that the lichens are very much useful to human being for many diverse purposes. There is no earlier report from the current study spot. Still now that is the first time information on the lichens of Sillery Gaon. We only done the morphology, structure and taxonomic work. There is a adequately chance for additional more study on economically and socially important lichens from this region.

ACKNOWLEDGMENT

I am very gratified to University of Kalyani for providing research laboratory. I am also thankful to Prof. (Dr.) Sankar Narayan Sinha for his appreciated suggestion.

REFERENCES

1. (Kosanic M, Rankovic B, Stanojkovic T, Rancic A and Manojlovic N. Cladonia lichens and their major metabolites as possible natural antioxidant , antimicrobial and anticancer agents . LWT-Food Sci Technol(2014) 59 (1):518-25 and Rankovic,2010)
2. Crawford SD. Lichens used in traditional medicine. In: Rankovie B, editor. Lichen secondary metabolites. Switzerland: Springer International Publishing . (2015) 27-80.
3. Richardson DHS. Medicinal and other economic aspects of lichens. In :Handbook of lichenology. Boca Raton: CRCPress (1988).
4. Rankovic B, Misic S, Sukdolak S. Antimicrobial activity of extracts of the lichens Cladonia furcate, Parmelia caperata, Parmelia pertusa, Hypogymnia physodes and Umbilicaria polyphylla. British Journal of Biomedical Science, (2007) 64(4) 143-148.
5. Upreti DK, Divakar PK, Nayaka S. Commercial and ethnic use of lichens in India. Economic Botany, (2005) 59(3) 269.
6. Rashmi S and Rajkumar HG. Preliminary phytochemical screening of different solvent extracts of lichens from Kodagu district, Karnataka. Journal of pharmacognosy and phytochemistry, (2014) 3(4) 209-212.
7. Lee KA and Kim MS. Glucosidase inhibitor from Umbelicaria esculenta. Can. J. Microbiol, 46(11) (2000) 1077-81.
8. Rajaram SK, Innasimuthu GM, Anuf AR, Varghese R, Munusamy M, Nayaka S, Upreti DK. Antioxidant activity of lichen Parmotrema austrosinense and its antimicrobial effect on selected plant pathogens. Cryptogam Biodiversity and Assessment, (2016)1. DOI: 10.21756/cab.v1i2.7033
9. Upreti DK, Divakar PK, Nayaka S. Commercial and Ethnic Use of Lichens In India. Economic Botany (2005) 59(3) 269-273.

10. Lal BM and Upreti DK. Ethnobotanical notes on three Indian lichens. Lichenologist, (1995) 27(1) 77-99.
11. Ohmura Y, Kawachi M, Kasai F, Sugiura H, Ohtara K, Kon Y, Hamada N. Morphology and Chemistry of Parmotrema tinctorum Transplanted into sites with different air pollution levels. Bulletin of the National Museum of Nature and Science, Series B, (2009) 35.
12. Kumar KC and Mueller K. Lichen metabolites 2: Antiproliferative and Cytotoxic activity of Gyrophoric, Usnic and diffractaic acid on human keratinocyte growth. J. Nat. Prod, (1999b) 62 (6) 821-823.
13. Swamy CT, Gayathri D, Devaraja TN. Antibacterial activity of lichens Parmotrema tinctorum and Pyxine sorediata and their secondary metabolites. IJALS,(2016) ONLINE ISSN : 2277-758X.
14. Moskalenko SA. Preliminary screening of far-estern ethnomedicinal plants for antibacterial activity. J Ethnopharmacology, (1986) 15 321-259.
15. Pennington CW. The Tepehuan of Chihuahua. Univ. of Utah Press. (1963).
16. Burkholder PR and Evans AW. Further studies on the antibiotic activity of lichens. Bulletin of the Torrey Botanical Club/Bull. Torrey Bot. Club. (1945) 72 157-164.
17. Gupta VK, Darokar MP, Saikia D, Pal A, Fatima A and Khanuja SPS. Antibacterial activity of lichens. Pharmaceutical Biology, (2007) 45(3) 200-204.
18. Casselman, Karen D. Lichen Dyes: The New Source Book. Mineola, NY, US: Dover Publications. P 35. (2001) ISBN 978-0-486-41231-3.
19. Rankovic and Branislav. Lichen secondary metabolites: Bioactive properties and pharmaceutical potential. Switzerland: Springer Publishing. P 49. (2015) ISBN 978-3-319-13373-7.
20. Kosanic MM, Rankovic BR, Stanojkovic TP. Antioxidant, antimicrobial and anticancer activities of three Paemelia Species. J Sci Food Agric, (2012) 92(9) 1909-16.
21. IFRA standards library: oakmoss.
22. Aslan A, Gulluce M, Sokmen M, Adguzel A, Sahin F, Ozkan H. Antioxidant and antimicrobial properties of the lichens Cladonia foliacea, Dermatocarpon miniatum, Evernia divaricate, Evernia prunstri and Neofuscella pulla. Pharmaceutical Biology. (2006) 44(4) 247-252.
23. Wales-lichens.org.uk > species-account.
24. https://www.sciencedirect.com > topics.
25. Rankovic B, Misic M, Sukdolak S. The antimicrobial activity of substances derived from the lichens Physcia aipolia, Umbilicaria polyphylla, Parmelia caperata and Hypogymnia physodes. World J. Microbiol. Biotechnol, (2008) 24 1239-1242.
26. YamamotoY, Kinoshita Y, Matsubara H, Kinoshita K, Koyama K, Takahashi K, Kurokawa T and Yoshimura I. Screening of biological activities and isolation of biological active compounds from lichens. Recent Res. Devl. In phytochem, (1998) 2 23-33.