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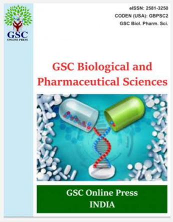

(RESEARCH ARTICLE)

Host plant specificity of corticolous lichens in urban and suburban New Amsterdam, Berbice, Guyana

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Abstract

In this study, host plant - lichen specificity was investigated. Data was collected from $1000m^2$ sampling plots at each of four locations with an established 50m x 20m plot at each site. Forty-one trees from across five species were examined using (10cm by 50cm) ladder quadrats on tree trunks (N, S, E, W) at 150cm height. A total of 14978 individual lichens were identified that yielded 10 families, 13 genera and 18 species. *Swietenia mahagoni* showed the highest average corticolous lichen species composition, followed by *Terminalia catappa* and *Melicoccus bijugales* respectively. *Cocos nucifera* had a higher average species recorded than *Mangifera indica*. Crustose lichens were the most prominent corticolous lichens observed (61%) with the most individuals in Graphidaceae and Arthoniaceae. Foliose lichens (28%) showed the most abundance in Parmeliaceae, Caliciaceae and Collemataceae. Of the taxa recorded, 22.2% were restricted to specific trees. *C. parasitica*, *H. laevigata*, *U. cornuta* were restricted to *S. mahagoni.* *D. applanata* was restricted to *C. nucifera*. 22.2% of recorded species were found on all of the tree hosts that were examined. *Bacidia laurocerasi*, *Flavoparmelia caperata*, *Flavoparmelia soredians* and *Graphina anguina*. *S. mahagoni* hosted 88.9% of all recorded species. *Swietenia mahagoni* showed the highest average of recorded corticolous lichen species of all host trees with 7.58. *Mangifera indica* showed the lowest average with 4. The maximum number of species (10) was recorded on one *S. mahagoni* tree.

Keywords: Corticolous lichens; Host plant specificity; Urban, Suburban; New Amsterdam, Guyana

1. Introduction

Host plants provide space for different types and species of lichens [1]. Preference is shown by some lichens for certain trees and this may be based on different factors inclusive of the nature of the bark, microclimatic and chemical conditions [2]. It is important to understand host preferences when considering lichen ecology, because of the important roles that lichens play in ecosystems [3] [4] [5] [6].

In addition, an understanding of host specificity of lichens may be useful when considering their diversity and conservation [1]. Although there are many publications on studies done on lichen relationships in other countries [1] and in the tropical forests of Guyana [7] [8] [9] [10] [11] [12] [13] [14] there appears to be a dearth of information available for lichens especially for urban and suburban areas in Guyana.

Epiphytic lichens growing on the surface of plants, are often used as bio-indicators of environmental quality [15] and are also useful as indicators of environmental disturbances [16]. However, lichen data necessary for environmental impact and conservation assessments in rural, urban and suburban areas is somewhat limited for Guyana.

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The main objective of this study was to investigate the host tree specificity of corticolous lichens in suburban and urban New Amsterdam. The key research question that was addressed in this study was whether there was lichen-host tree specificity in suburban and urban New Amsterdam.

This study has the potential to add to the body of knowledge of corticolous lichen flora in an urban settlement in Guyana. The results from this study can be a useful baseline to investigate the effects of urbanization on local corticolous lichen biodiversity while helping to inform other assessments and management decisions concerning Guyana's lichen diversity.

2. Methodology

2.1. Study Area

This study was conducted in New Amsterdam, Berbice, Guyana. Four study sites were identified: two (Site #1 and Site #2) were classified as urban locations and two (Site #3 and Site #4) were classified as suburban locations.

2.2. Sampling and Data Collection

Field work was completed during the period February - May, 2019 and data was collected from sampling plots of 1000m^2 at each location where a plot of 50m x 20m was established at each site.

Sampling plots were laid out randomly for sampling and corticolous lichens were only sampled on undamaged trees with a girth of more than 70cm [17] [18].

Ladders measuring 10cm x 50cm and each having five 10cm x 10cm contiguous quadrats were used to sample the tree trunks. Each ladder was placed on the tree trunk on the north, south, east and west directions such that the upper edge of each ladder was 1.5m above the highest point on the ground [19].

Lichen species, their associated host plants and the frequency observed within each of five randomly placed 10cm x 10cm quadrats of the ladder were recorded. Lichen species cover was estimated to the nearest cm^2 and expressed as a percentage of the inspected trunk area [16].

2.3. Identification of lichens

Lichen specimen identification was done on the basis of morphological observations of the thalli and apothecia of the corticolous lichens with the use of a magnifying glass. The following were also used for the identification of lichens [20] [21] [22] [23] [24] [25].

2.4. Data Analysis

Statistical analyses and calculations were done using PAST 3.24 Statistical software.

3. Results

This study focused on investigating lichen – host plant specificity of corticolous lichens at four study sites in New Amsterdam. Lichen specimens were collected from a total of 41 host trees. 14978 lichen specimens were recorded during the study, representing 10 families, 13 genera and 18 species (Table 1).

Table 1 Species frequency distributed over sample sites

Family	**Species**	**Site #1**	**Site #2**	**Site #3**	**Site #4**	**Suburban (Sites #3&4)**	**Urban (Sites #1&2)**	**New Amsterdam (Total Sites)**
Monoblastiaceae	*Anisomeridium biforme*	56	206	196	51	247	262	509
Arthoniaceae	*Arthonia cinnabarina*	0	0	176	0	176	0	176
	Arthonia pruinata	0	182	0	0	0	182	182
	Arthonia radiata	718	351	66	887	953	1069	2022
Ramalinaceae	*Bacidia laurocerasi*	42	110	176	329	505	152	657
Cladoniaceae	*Cladonia parasitica*	49	0	0	0	0	49	49
Collemataceae	*Collema furfuraceum*	1256	205	88	0	88	1461	1549
Coenogoniaceae	*Dimerella lutea*	291	0	0	0	0	291	291
Caliciaceae	*Dirinaria applanata*	0	0	191	2816	3007	0	3007
Parmeliaceae	*Flavoparmelia caperata*	748	462	479	277	756	1210	1966
	Flavoparmelia soredians	405	900	46	41	87	1305	1392
	Hypotrachyna laevigata	24	0	0	0	0	24	24
	Usnea cornuta	3	0	0	0	0	3	3
Graphidaceae	*Graphina anguina*	250	261	415	143	558	511	1069
	Graphis elegans	31	44	16	43	59	75	134
Lecanoraceae	*Lecanora chlarotera*	56	48	28	427	455	104	559
	Lecanora confusa	222	0	112	258	370	222	592
	Lecanora conizaeoides	726	71	0	0	0	797	797
		4877	2840	1989	5272	7261	7717	14978

When all sites were considered, crustose corticolous lichens species were the most recorded (61%), while squamulose (5%) and fruticose (6%) were the least recorded (Fig. 2).

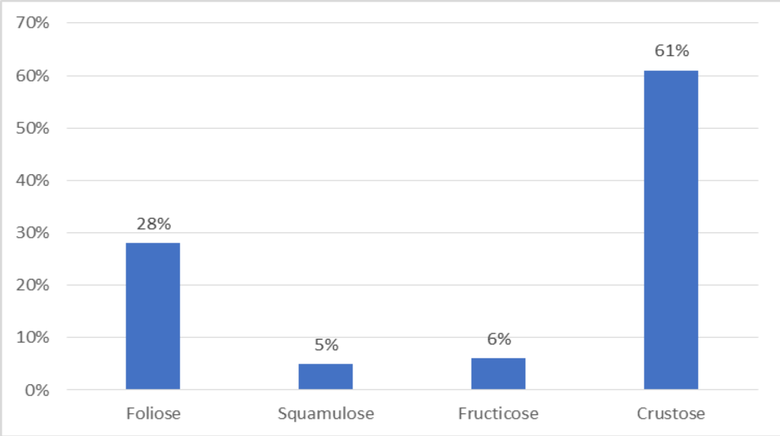

Figure 2 Lichen distribution according to type of thallus

Table 2 Summary of evidence of anthropogenic influence, number of trees sampled and lichen species found

Study site	Anthropogenic influence observed at study site	Number of trees sampled	Species of tree sampled	Number of lichen species identified at study site
#1	Yes	11	*Swietenia mahagoni*, *Melicoccus bijugales*	15
#2	Yes	6	*Terminalia catappa*, *Swietenia mahagoni*	12
#3	Yes	9	*Cocos nucifera*, *Mangifera indica*, *Melicoccus bijugales*	13
#4	Yes	15	*Cocos nucifera.*	10

3.1. Host Tree Specificity

Swietenia mahagoni showed the highest average corticolous lichen species presence, followed by *Terminalia catappa* and *Melicoccus bijugales* respectively. *Cocos nucifera* had a higher average species recorded than *Mangifera indica*.

Four species of lichens showed specificity towards host trees and four species showed no host specificity and were observed on all five of the tree species sampled. Table 3 and Figure 4 give the species that showed specificity and their associated specific host tree were: *Cladonia parasitica* [Host tree - *Swietenia mahagoni*]; *Dirinaria applanata* [Host tree - *Cocos nucifera*]; *Hypotrachyna laevigata* [Host tree - *Swietenia mahagoni*]; *Usnea cornuta*, [Host tree - *Swietenia mahagoni*].

Table 3 Host specificity of lichens for the five recorded tree species

Lichen Species	***Cocos nucifera***	***Mangifera indica***	***Melicoccus bijugales***	***Swietenia mahagoni***	***Terminalia catappa***
Anisomeridium biforme	✓	✓		✓	✓
Arthonia cinnabarina		✓	✓		
Arthonia pruinata				✓	✓
Arthonia radiata	✓	✓		✓	✓
Bacidia laurocerasi	✓	✓	✓	✓	✓
Cladonia parasitica				✓	
Collema furfuraceum		✓	✓	✓	✓
Dimerella lutea			✓	✓	
Dirinaria applanata	✓				
Flavoparmelia caperata	✓	✓	✓	✓	✓
Flavoparmelia soredians	✓	✓	✓	✓	✓
Hypotrachyna laevigata				✓	
Usnea cornuta				✓	
Graphina anguina	✓	✓	✓	✓	✓
Graphis elegans	✓		✓	✓	✓
Lecanora chlarotera	✓			✓	
Lecanora confusa	✓			✓	
Lecanora conizaeoides			✓	✓	✓

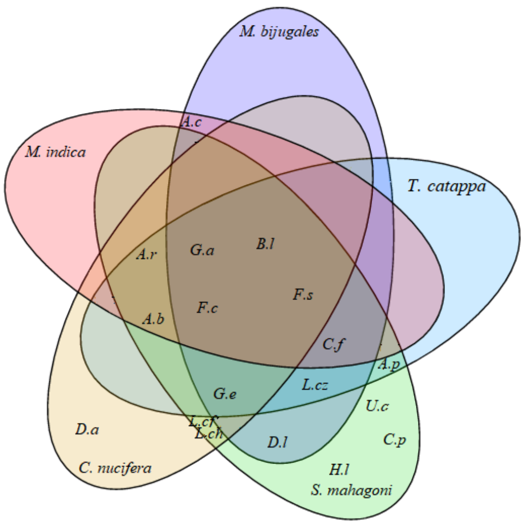

Figure 4 Illustration of host tree specificity of observed corticolous lichens. N.b. A.b – *Anisomeridium biforme*; A.c – *Arthonia cinnabarina*; A.p – *Arthonia pruinata*; A.r – *Arthonia radiata*; B.l – *Bacidia laurocerasi*; C.p – *Cladonia parasitica*; C.f – *Collema furfuraceum*; D.l – *Dimerella lutea*; D.a – *Dirinaria applanata*; F.c – *Flavoparmelia caperata*; F.s – *Flavoparmelia soredians*; H.l – *Hypotrachyna laevigata*; U.c – *Usnea cornuta*; G.a – *Graphina anguina*; G.e – *Graphis elegans*; L.ch – *Lecanora chlarotera*; L.cf – *Lecanora confusa*; L.cz – *Lecanora conizaeoides*.

4. Discussion

All around the world, species appear to be under threats from anthropogenic activities and lichens have been noted among such species. [26] notes that there will be major challenges to humans and biodiversity as a result of climate change. Further, with pending sea level changes that could impact coastal locations, the exclusion of lesser-known yet ecologically important species from assessments of biodiversity can have implications for global and local conservation strategies [27].

The current study location lies within Guyana's coastal Plain which has the potential to be seriously impacted by sea level change. Therefore as [26] [27] have noted, it is important to pay attention to lesser known groups such as lichens as well as the pending implications of sea level change for coastal locations.

A total of 14978 lichen representatives belonging to 10 families, 13 genera and 18 species of corticolous lichens were recorded from these four sites.

The results revealed that 22.2% of all recorded corticolous lichen species were restricted to specific trees. *C. parasitica*, *H. laevigata*, *U. cornuta* were restricted to *S. mahagoni* and *D. applanata* were to *C. nucifera*). 22.2% species were found on all tree hosts: *Bacidia laurocerasi*, *Flavoparmelia caperata*, *Flavoparmelia soredians* and *Graphina anguina* and *S. mahagoni* was host to 88.9% of all recorded species.

It should be noted, however, that factors which may influence host specificity, such as bark pH, water content, porosity, degree of bark shading, presence of tree sap [28], were not investigated in this study. Investigating these factors in future research in urban and suburban areas in Guyana could shed light on host plant – lichen specificity and likely offer an explanation as to the reasons for any observed patterns.

Swietenia mahagoni showed the highest average of recorded corticolous lichen species of all host trees with 7.58 and *Mangifera indica* showed the lowest average with 4. The maximum number of species recorded from a tree was 10 on *S. mahagoni* trees. This number of species could be due to the fact that only a part of the tree trunk was sampled since different lichen species inhibit varying levels of a tree [29].

Crustose lichens were the most prominent corticolous lichens observed (61%) with most individuals in Graphidaceae and Arthoniaceae. However, foliose lichens (28%) showed the most abundance in Parmeliaceae, Caliciaceae and Collemataceae.

Both urban and suburban sites had three species of host trees each. For the urban sites the species were *Melicoccus bijugales*, *Swietenia mahagoni* and *Terminalia catappa* while for the suburban sites the host tree species were *Cocos nucifera*, *Mangifera indica* and *Melicoccus bijugales*. With a decrease in host tree specificity observed at Site #4, there was an apparent decrease in corticolous species richness. Although Site #4 had the lowest number of lichen species (10), this site was the one with the greatest number of individuals.

The results also revealed that 83.3% of all species were encountered in more than one study site. *Cladonia parasitica*, *Hypotrachyna laevigata* and *Usnea cornuta* were however restricted to *Swietenia mahagoni* trunks in site #1 while *Dirinaria applanata* was restricted to *Cocos nucifera*, and was found in sites #3 and #4.

5. Conclusion

Host plant specificity was observed for four species of the recorded lichens. Three species were specific to *S. mahagoni* and one species was specific to *C. nucifera*.

There was a higher number of crustose lichens as compared to foliose, fruticose and squamulose.

There is a need for further studies to examine other parts of the tree to determine if there is a difference in the lichen diversity based on the part of the host plant.

As it pertains to host specificity, future studies should investigate the bark characteristics that are known to influence lichen appearances to see if there is indeed a relationship between lichens and tree hosts.

Lichens are good bio-indicators of ecological health and therefore, studies pertaining to assessing and monitoring ecosystem and environmental health, especially urban areas, can focus on using lichens.

It will be important to also factor the impacts of climate change into any future study of lichens in coastal areas in Guyana.

This study was a preliminary investigation on host-plant lichen specificity in urban and suburban settings in Guyana. Given that previous research has demonstrated the value of lichens as indicators of air pollution, other studies of this nature in Guyana may be helpful, given that there is much development taking place in urban and suburban areas which can likely increase the instances of pollution.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare there are no conflicts of interest.

References

[1] Joshi, Tripathi, Jinnah, Bisht, Upreti. Host specificity of epiphytic macrolichens: A case study of Jageshwar forest (Uttarakhand) India. Tropical Ecology. 2016; 57(1): 1-8.

[2] Barkman JJ. Phytosociology and Ecology of Cryptogamic Epiphytes. Van Gorcum, Assen. 1958; 628.

[3] Dettki H, PA Esseen. Epiphytic macrolichens in managed and natural forest landscapes: a comparison at two spatial scales. Ecography. 1998; 21: 613-624.

[4] Kuusinen M, J Siitonen. Epiphytic lichen diversity in old-growth and managed Picea abies stands in southern Finland. Journal of Vegetation Science. 1998; 9: 283-292.

[5] Lesica P, B. McCune SV, Cooper, WS Hong. 1991. Differences in lichen and bryophyte communities between old-growth and managed second-growth forests in the Swan Valley, Montana. Canadian Journal of Botany. 1991; 69: 1745-1755.

[6] Pharo EJ, AJ Beattie, D Binns. Vascular plant diversity as a surrogate for bryophyte and lichen diversity. Conservation Biology. 1999; 13: 282-292.

[7] Hekking W, Sipman H. The Lichens Reported from the Guianas before 1987. Willdenowia. 1988; 17(1/2): 193-228.

[8] Boom P, Sipman H. Foliicolous lichens from Suriname and Guyana: new records and three new species. 2016.

[9] Cornelissen J, Steege H. Distribution and ecology of epiphytic bryophytes and lichens in dry evergreen forest of Guyana. Journal of Tropical Ecology. 1989; 5(2): 131-150.

[10] Sipman HJM. Observations on the foliicolous lichen and bryophyte flora in the canopy of a semi-deciduous tropical forest. Abstracta Botanica. 1997; 21(1): 153–161.

[11] Sipman HJM. Notes on the lichen flora of the Guianas, a neotropical lowland area. In: Galloway, D.J. (ed.): Tropical Lichens: Their Systematics, Conservation, and Ecology. Systematics Association Special Volume, Clarendon Press, Oxford. 1991; 135–150.

[12] Sipman H. Observations on the foliicolous lichen and bryophyte flora in the canopy of a semi-deciduous tropical forest. Abstracta Botanica. 1997; 21(1): 153-161.

[13] Sipman HJM, Aptroot A. Results of a botanical expedition to Mount Roraima, Guyana. II. Lichens. Tropical Bryology. 1992; 5: 79–108.

[14] Steege H ter, Cornelissen JHC. Collecting and studying bryophytes in the canopy of standing rainforest trees. In: Glime, J. M. (ed.). Methods in bryology. Proc. Bryol. Meth. Workshop, Mainz. Publ. Hattori Bot. Lab., Nichinan.Google Scholar. 1988.

[15] Munzi S, Correia O, Silva P, Lopes N, Freitas C, Branquinho C, Pinho P. (2014). Lichens as ecological indicators in urban areas: beyond the effects of pollutants. Journal of Applied Ecology. 2014; 51: 1750-1757.

[16] Lättman H, Bergman K, Rapp M, Tälle M, Westerberg L, Milberg P. (2014). Decline in lichen biodiversity on oak trunks due to urbanization. Nordic Journal of Botany. 2014; (32)4: 518-528.

[17] Asta J, Erhardt W, Ferretti M, Fornasier F, Kirschbaum U, Nimis PL, Purvis OW, Pirintsos S, Scheidegger C, van Haluwyn C, Wirth V. (2002). Mapping Lichen Diversity as an Indicator of Environmental Quality. Nimis, P. L., Scheidegger and Wolseley P. A. (eds.). Monitoring with Lichens. 2002; 273–279.

[18] Scheidegger C, Groner U, Stofer S. Biodiversity Assessment Tools—Lichens. Nimis, P.L., Scheidegger, C. and Wolseley, P.A. (eds.) Monitoring with Lichens 359—365. Kluwer Academic Publishers, Netherlands. 2002.

[19] Kirika PM. Diversity, Ecology and Altitudinal Distribution of Corticolous Lichens in Mount Kenya Tropical Montane Forest. 2012.

[20] Dobson FS. Guide to common urban lichens 1 (on trees and wood) Field Studies Council, OP98. 2005.

[21] Dobson FS. A Field Key to Lichens on Trees. Intype Libra Ltd. Wimbledon. 2013.

[22] Nash TH, Ryan BD, Gries C, Bungartz F. Lichen Flora of the Greater Sonoran Desert Region. Vol 1. Arizona State University Lichen Herbarium. 2002.

[23] Nash TH, Ryan BD, Gries C, Bungartz F. Lichen Flora of the Greater Sonoran Desert Region. Vol 2. Arizona State University Lichen Herbarium. 2004.

[24] Nash TH, Ryan BD, Gries C, Bungartz F. Lichen Flora of the Greater Sonoran Desert Region. Vol 3. Arizona State University Lichen Herbarium. 2007.

[25] Nash TH. Lichen Biology Second Edition. Cambridge, UK: Cambridge University Press. 2008.

[26] Cardinale B, Duffy J, Gonzalez A, et al. Biodiversity loss and its impact on humanity. Nature. 2012; 486: 59–67.

[27] Lendemer JC, Allen JL. Lichen Biodiversity under Threat from Sea-Level Rise in the Atlantic Coastal Plain, BioScience. October 2014; 64(10): 923–931.

[28] Caceres MES, Lücking R, Rambold G. Phorophyte Specificity and Environmental Parameters versus Stotochasticity as Determinants for Species Composition of Corticolous Crustose Lichen Communities in the Atlantic Rain Forest of Northeastern Brazil. Mycol. Progress. 2007; 6: 117-136.

[29] Komposch H, Hafellner J. (2000). Diversity and Vertical Distribution of Lichens in Venezuelan Tropical Lowland Rain Forest. Selbyana. 2000; 21(1, 2): 11–24.