GSC Biological and Pharmaceutical Sciences

eISSN: 2581-3250 CODEN (USA): GBPSC2

Cross Ref DOI: 10.30574/gscbps

Journal homepage: https://gsconlinepress.com/journals/gscbps/

(Review Article)

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A review of the diversity of lichens and what factors affect their distribution in the neotropics

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GSC Biological and Pharmaceutical Sciences, 2022, 20(03), 027–063

Publication history: Received on 01 August 2022; revised on 03 September 2022; accepted on 05 September 2022

Article DOI: https://doi.org/10.30574/gscbps.2022.20.3.0348

Abstract

The purpose of this paper is to review published literature on the diversity of lichens and the factors that affect its distribution in the neotropics. The systematic method was used to research works of literature on "Diversity of lichens and what factors affect their distribution in the neotropics." A total of forty-nine research papers published between the years 1996 to 2021 was selected and utilized for this review. The results obtained was presented in tables. A subjective approach was then used to select the subtopics: lichens and their impact- benefits and importance. In this paper, twelve (12) neotropical countries were evaluated and a grand total of four hundred twenty-seven (427) lichens species of lichens from fifty-eight (58) lichen families were presented. Lichen distribution and habitats, diversity of lichens and factors that affect the distribution of lichens in the neotropics were also discussed. The published papers established that lichens have a rich diversity globally, they have many benefits and importance, they are widely distributed across the landscape and are found in a wide range of habitats. Many abiotic factors such as temperature, pH, humidity, moisture, latitude, topography, light availability and anthropogenic activities by human beings e.g., pollution and deforestation play a heavy influence on lichens and their distribution in the neotropics as well as globally. More studies should be done in the neotropics since data is limited and in demand.

Keywords: Neotropics; Foliicolous lichen; Lichenicolous fungus; Distribution; Diversity; Factors

1. Introduction

1.1. Lichens

Lichens are slow-growing organisms that tolerated extreme environmental changes for hundreds of years [74]. Lichen is a Greek word that refers to the surface growth on the olive tree's bark. Around 300 BC, Theophrastus, the Father of Botany, coined the term "lichen" to describe a plant group [88], [89]. Lichens are found all over the world and number between 15,000, and 20,000 species. Many of them are specialized to specific ecosystems and only appear seldom throughout landscapes, while others are rare in nature [87], [98].

Lichens were formerly classed as a single organism, but due to previous descriptions based on their outward appearance, they were gradually mistaken for bryophytes (mosses) in some situations, and seaweeds in others. Scientists began to document the comprehensive anatomy of lichens when microscopes were constructed and introduced in the early 1800s, and were able to establish their real nature [83], [87], [119].

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Lichen is a type of living organism that was created by symbiotic relationships between a fungus and an alga or cyanobacteria [87], [108], [109], [135]. The mycobiont, which produces the main lichen body and gives the lichen its key characteristics (from the shape of its thallus to the type of fruiting body), is heterotrophic and regarded as the dominant partner. The autotrophic algae or cyanobacteria is known as the photobiont, and it is found between the upper and lower fungal cortex [67], [83], [87], [104], [108], [119], [135].

Photosynthesis supplies sustenance to the photobiont, which feeds the fungus and allows it to propagate. For its algal companion, the mycobiont provides structural support and requires protection [104], [108], [109], [116], [135]. Water and other necessary liquids are transported back and forth from the mycobiont to the photobiont [108], [109], [118], [135].

The upper cortex of several lichen species has specialized apertures that range in color from bright to subdued to dark hues. Because they produce small airborne spores, these formations are known as 'fruit bodies' or 'fruiting bodies.' A new lichen thallus is generated when these spores find a matching photobiont partner (algae or cyanobacteria) [45], [87], [104], [119].

Many lichens, develop propagules that are capable of detaching and growing into a new lichen body. Powdery structures, also known as soralia, are the most prevalent type of propagule, and they appear as pustules on the upper cortex. These are excellent in dislodging small clusters of soredia (algal cells) bound together by the fungus' hyphae. Isidia, which include both algal and fungal cells, are another structure that lichens use for vegetative reproduction [20], [41], [87], [119].

This lichen union permits a diversified floral group to occupy a variety of ecological niches on a variety of biological or physical substrates where fungi, algae, or cyanobacteria would struggle to exist on their own [116]. Desiccation tolerance is high in many lichens; therefore, they can withstand extremely hot or low temperatures.

Lichens inhabit a variety of settings and are sometimes referred to as pioneer species. They can be found in practically all terrestrial ecosystems, including hot deserts, rocky beaches, and tropical rainforests, as well as cold polar locations such as artic tundra, and even high-altitude situations. Other extreme habitats, such as toxic slag heaps, are also home to lichen species [51], [83]. Further, lichenized fungus has an estimated range of thirteen thousand five hundred to twenty thousand (13,500-20,000) species globally, with Ascomycetes accounting for more than half (50%) of those reported [56].

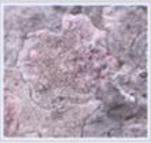
Xanthoria parietina	*Usnea florida*	*Lecanora concolor*	*Bagliettoa cazzae*	*Lathagrium cristatum*	*Squamarina cartilaginea*	*Cladonia polydactyla*	*Lepraria membranacea*
							
Leaf-shaped thallus (foliose) Easily detached from the substrate	Fruticose thallus more or less branched and hanging Reduced contact surface with the substrate	Crust-like thallus (crustose) Can only be detached with a hammer and a chisel	Crust-like thallus (crustose) Can only be detached with a hammer and a chisel	Solid, black and brittle thallus in dry condition Becomes gelatinous under the action of rain	Squamulose thallus. Formed by small scales (or squamula) intertwined like the tiles of a roof	Complex : - primary thallus very adherent to the substrate - secondary erect thallus (or podetion) in the shape of a trumpet or stems	Leprose thallus, with a mealy appearance
Fixed on bark from isolated, dust-rich trees	Especially on hardwood trunks and branches in humid forests or isolated trees	Encrusted, adheres to high altitude siliceous rocks	Encrusted, frequent on sunny limestone walls in the south of France	Fixed on limestone rocks	Look for rocks or calcareous soils. Common in the south of France	On rotten wood, at the base of mossy trunks, seeks moisture and light	On shaded siliceous rocky escarpments and in a humid atmosphere, sometimes on soil or moss

Figure 1 The main types of lichens with relevant examples, characteristics of their thallus and the thallus and the relationship with their substrate (Asta, 2022)

Lichens can be found in a variety of different growth types [20], [87], [83], [104], [119] have a variety of hues, such as black, white, orange, grey, yellow, green, and others, and are classified according to their growth forms. Crustose lichens grow in a crust-like state. Others called foliose lichens are leafy, and fruticose lichens are shrub-like.

Lichens are also categorized by the wide range of substrates they utilize (Figure 1). Corticolous lichens grow on the barks of vascular plants, muscicolous lichens grow on the tops of mosses, saxicolous lichens live on rocks, terricolous lichens live in the soil, lignicolous lichens grow on bark-striped wood, and foliicolous lichens grow on the leaf of vascular plants [87], [119]. Corticolous microlichens are the most numerous lichen species, but they are also the least well-studied [5], [45], [56].

Lichens are vital to the habitats where they live, working with various trees and plants to ensure the survival and functionality of the ecosystems [116], [119]. Lichens have been used as a major biological indicator for monitoring anthropogenic disturbances such as air pollution, acid rain, nitrogen (N) deposition, and a variety of other environmental conditions for many years [15], [20], [40], [42], [45], [67].

Lichens were also widely employed as a source of food and to extract compounds such as colors and antibacterial agents [74], [80]. In the world of science, however, lichens have limited medical use [8]. Lichens and their environments are also crucial keystone species to many species of organisms that have yet to be discovered and described, such as arthropods, birds, and mammals [45], [98].

1.2. Benefits and Importance of Lichens

The lichen *Rocella tinctoria*, is used in the production of orcein, which serves as a biological stain. The *Rocella tinctoria* was also applicable as a source of litmus, pH indicator, prior to the synthetic production of litmus. Many of the pH indicator, litmus test and other dyes utilized in laboratories are extracted from different lichen species [9], [77]. Moreover, some lichen species e.g., *Ramalina* and *Evemia* are used as scented incense and the production of incense sticks. Other lichen species for example, *Lobularia pulmonaria* and *Evemia prunastri* are used to create different brands of perfumes [77]. Lichens were also noted for playing a major role in cosmetology and the cosmetic industries utilize them as a natural medicine to treat various rashes and skin diseases [15].

When the seasons are particularly hot, the *Usnea* lichen can potentially cause forest fires. Some lichens grow on concrete, window panes, and stones in high-humidity environments, and they can harm and destroy buildings over time through erosion [77]. Some lichens, such as *Usnea* and *Cladonia*, are used for their antibacterial capabilities, and usnic acid is extracted and employed in the pharmaceutical formulation of ointments to heal burns and wounds [77], [135]. Many lichens are also employed in the pharmaceutical industry to make anti-mycobacterial, antiviral, and other anti-inflammatory drugs [15].

Lichens are the first colonizers in barren regions such as dry, naked rocks, cliffs, mountains, and other settings that favor primary succession. Lichens aid in the eroding of rocks and cliffs during the growth development stage by secreting specific acids that can penetrate the rocks with their hyphae. As a result, it creates tiny gaps where organic materials can gather, allowing for the formation of additional species [44]. As a result, petrologists and geologists can analyze and identify the age and other properties of surfaces and rocks by analyzing the size of lichens [15].

Porada *et al*. discovered in 2018 that non-vascular plants, such as lichens and mosses, catch a significant quantity of rainwater. They have the potential to influence the climate and the global water cycle by increasing the evaporation of free-flowing water by around 61 percent (61%). Furthermore, because of the algal symbiont, they play an important role in nitrogen fixation. Lichens aid in the conversion of nitrogen from the atmosphere to nitrate (NO_3). Certain nitrates are leached from the lichens and used by various soil-based plants when it rains [44].

Further, lichens are unable to endure pollution since they require fresh, clean air to efficiently support their growth. As a result, lichens can absorb heavy metals and carbon dioxide (CO_2) from the air [15], [44]. As a result, lichens play an important role in biodegradation by breaking down pollutants such as polyester (PS), lead (Pb), copper (Cu), radionuclides, and other contaminants that pollute the environment. Lichens are also utilized in the degrading of viruses and other environmental reservoirs that can cause devastating infectious diseases in plants, animals, and humans [15].

Sulphurous and nitrogenous oxides can harm delicate lichens in some agricultural ecosystems [43]. Environmental scientists and researchers use this characteristic of lichen to determine the level of contamination in a given ecosystem by detecting and quantifying the quantities of contaminants in a certain lichen species. As a result, lichens are regarded as effective biomonitors of healthy ecosystems [44]. In Pistoia, central Italy, Loppi & Corsini (2003) used epiphytic lichen biodiversity and the accumulation of heavy metals in the thalli of a species of corticolous lichen, *Parmerlia caperata*, as an indicator of air pollution.

2. Material and methods

A systematic review was conducted using "Google Scholar," a web-based search engine which provides a quick and easy way to search and access published articles, journals and books on the topic "Diversity of lichens and what factors affect their distribution in the neotropics". Thematic keywords such as lichens, diversity, neotropics, factors, distribution were used in the search.

An approach was used to select the themes that were discussed by reading through the abstracts and findings from the related works of literature. The publications that were obtained were restricted to the years 2000 to 2022. However, not all the papers that were obtained were used, as the sole purpose was to gather information from works of literature from the past 5 to 10 years relating to diversity of lichens and the factors that affect their distribution in the neotropics. However, papers with relevant work were also utilized that dates back as far as 1996 and the 2000's. A total of forty-nine (49) research articles was utilized in this review.

The search yielded various results: Some articles had all the thematic keywords and some were obtained that were specific to the Neotropics.

3. Results

A total of 71,300, results were obtained from "Google Scholar" when diversity of lichens and what factors affect their distribution in the neotropics. Among the results obtained, 32,800 were published within the years 2000 to 2022, 49,500 were published between the years 2010 to 2022 and 41,500, were published between the years 2015 to 2022. 8,250 publications within 2010-2022 reviewed the diversity of lichen in the neotropics and 23,100 publications reviewed factors that affect lichen distribution in the neotropics.

However, not all of the results focused on the diversity of lichens and factors that affect their distribution together. Some focused solely on diversity of lichens in specific environments and the others focused solely on factors that affect their distribution. Additionally, a few papers discussed on the positive and negative impacts of lichens, lichens in biomonitoring and even lichen genetics.

4. Discussion

4.1. Lichen Distribution and Habitats

Lichens can thrive in a variety of conditions, with various abiotic elements influencing their development, such as moisture accessibility, light, wind-velocity, and temperature [12], [40]. Lichens have evolved to be resistant to scorching deserts and icy tundra. There are two [2] primary traits that are thought to play a part in their establishment: their tendency to dry out and their complex chemistry [58], [87], [104].

Lichens can be found all throughout the world, from the most southerly rocks in freezing Antarctica to tropical rain forests and even deserts with no consistent annual rainfall. Lichens can be found on rocky shorelines, freshwater lakes, and mountain streams in semi-aquatic sections of marine tidal zones. *Peltigera gowardii* is a lichen species that used to be known as western populations of *Peltigera hydrothyria* (or *Hydrothyria venosa*), and it can survive permanently submerged in places like spring-fed mountain streams [19], [97].

Many lichens and mosses are found in many terrestrial settings, and they tend to create a gradient, with mosses dominating regions that stay the wettest throughout the year (though some lichens are present) and even lichens dominating areas that stay the driest throughout the year. Among the lichens, some slopes are often visible. The chlorolichen species can be found in coniferous woods in the Pacific Northwest and California's north-coastal ranges. They have a common mossy zone near the ground; as they mature, long fruticose lichens known as alectorioid lichens (generally *Alectoria* and *Bryoria*) colonize the mid-canopy of trees; and as old-growth conditions develop, cyanolichens begin to colonize a specific zone in the tree's lower canopy, just above a mossy understory [77], [80].

Some lichens are only found in specific microhabitats. Some gradients can be detected traveling around a tree trunk, with mosses dominating the wettest sections receiving canopy drip, followed by larger fruticose and foliose lichens.

Researchers may locate a range of powdery crustose leprarioid lichens and minute pin-lichens with tiny stalked fruiting bodies as they transition to sheltered places that receive no direct liquid water. In very old-growth woods, these sheltering microhabitats thrive. In addition, extremely similar gradients can be seen in other places, such as on the face of a single huge rock [60], [98].

The environment in chilly Antarctica is harsh, and there is minimal flora. Lichens are the most common creatures found here, with over 350 species documented from the Antarctic region [58], [101]. The fruticose lichens of the *Usnea* genus and *Umbilicaria* species, which are dominant in the Antarctic region, can reach heights of about twenty centimeters (20 cm) and are considered the most important primary producers in these biomes. The structure and size of some crustose lichen thalli varies greatly over the sandstone [37]. Lichens have the ability to desiccate up to ninety-seven percent (97%) of water in a short period of time, making them an anabiotic illness [58]. *Psoroma antarcticum* was recently discovered in Antarctica's South Maritime Shetland and the South Orkney Islands, according to Park *et al*., 2018. This new species is closely related to the lichen *Psoroma hypnorum*, although it differs from it in several ways, including cup-shaped apothecia, smaller ascospores, and thalli with gray-to-black melanin [93].

Furthermore, certain lichens may persist for a long period in a water-deficient environment and then begin physiological activity when the conditions are right; these are known as poikilohydric lichens [8], [61], [131]. Drought resistance is a particular gene found in lichens, and its function can be deduced by transferring the gene to other organisms that deal with water shortages all over the world [5], [39], [136]. Following that, other studies revealed that lichens' drought resistance potential was dominating due to their antioxidant capacity [98], [129].

4.2. Diversity of Lichens in Neotropics

During the Smithsonian International Cryptogamic Expedition to Guyana, Lucking (1996) researched Foliicolous lichens and associated lichenicolous fungus. Guyana has a total of two hundred thirty-three (233) foliicolous lichen species and eighteen (18) lichenicolous fungus that have been documented and reported on (Table 1). Three (3) new lichens and two (2) new lichenicolous fungus were also discovered: *Arthonia grubei, Badimia subelegans, Calopadia pauciseptata, Opegrapha matzeri* (lichenicolous on *Amazonomyces sprucei*), and *Pyrenidium santessonii* (lichenicolous on *Bacidia psychotriae*). In addition, the investigation revealed that one hundred fifteen (115) of the new Neotropical records are new to Guyana, resulting in a total of two hundred eighty (280) genuine foliicolous species being reported for the country.

Table 1 Checklist of foliicolous lichens and their lichenicolous fungi collected during the Smithsonian International Cryptogamic Expedition to Guyana 1996 by Robert Lucking

No	Lichen species	No.	Lichen species	No.	Lichen species
1	*Actinoplaca strigulacea*	84	*Dictyonema phyllogenum*	167	*Phyllophiale aff. alba*
2	*Amazonomyces sprucei*	85	*Dimerella epiphylla*	168	*Phyllophiale fusca*
3	*Anisomeridium foliicola*	86	*Dimerella fallaciosa*	169	*Porina andreana*
4	*Anisomeridium musaesporoides*	87	*Dimerella flavicans*	170	*Porina atriceps*
5	*Arthonia accolens*	88	*Dimerella hypophylla*	171	*Porina atrocoerulea*
6	*Arthonia aciniformis*	89	*Dimerella isidiifera*	172	*Porina atropunctata*
7	*Arthonia atropunctata*	90	*Dimerella aff. pilifera*	173	*Porina curtula*
8	*Arthonia cyanea*	91	*Dimerella zonata*	174	*Porina distans*
9	*Arthonia flavoverrucosa*	92	*Echinoplaca diffluens*	175	*Porina epilucida*
10	*Arthonia grubei*	93	*Echinoplaca epiphylla*	176	*Porina epiphylla*
11	*Arthonia intermedia*	94	*Echinoplaca furcata*	177	*Porina fulvella*
12	*Arthonia lecythidicola*	95	*Echinoplaca fusconitida*	178	*Porina fusca*
13	*Arthonia leptosperma*	96	*Echinoplaca aff. fusconitida*	179	*Porina guianensis*

14	*Arthonia mira*	97	*Echinoplaca hymenocarpoides*	180	*Porina imitatrix*
15	*Arthonia palmulacea*	98	*Echinoplaca aff. incrustatociliata*	181	*Porina leptosperma*
16	*Arthonia pseudopegraphina*	99	*Echinoplaca leucotrichoides*	182	*Porina leptospermoides*
17	*Arthonia trilocularis*	100	*Echinoplaca marginata*	183	*Porina limbulata*
18	*Aspidothelium fugiens*	101	*Echinoplaca pellicula*	184	*Porina lucida*
19	*Aspidothelium* sp.n.	102	*Echinoplaca serusiauxii*	185	*Porina mirabilis*
20	*Asterothyrium leptosporum*	103	*Echinoplaca tricharioides*	186	*Porina aff. mirabilis*
21	*Asterothyrium leucophthalmum*	104	*Echinoplaca verrucifera*	187	*Porina nitidula*
22	*Asterothyrium aff. monosporum*	105	*Eremothecella calamicola*	188	*Porina nucula*
23	*Aulaxina aff. epiphylla*	106	*Fellhanera angustispora*	189	*Porina octomera*
24	*Aulaxina intermedia*	107	*Fellhanera badimioides*	190	*Porina papillifera*
25	*Aulaxina microphana*	108	*Fellhanera bouteillei*	191	*Porina radiata*
26	*Aulaxina minuta*	109	*Fellhanera cf. dispersa*	192	*Porina rubentior*
27	*Aulaxina opegraphina*	110	*Fellhanera emarginata*	193	*Porina rufula*
28	*Aulaxina quadrangula*	111	*Fellhanera fuscatula*	194	*Porina subepiphylla*
29	*Bacidia brasiliensis*	112	*Fellhanera lisowskii*	195	*Porina tetramera*
30	*Bacidia cf. corallifera*	113	*Fellhanera rhapidophylli*	196	*Porina vezdae*
31	*Bacidia psychotriae*	114	*Fellhanera santessonii*	197	*Pseudocalopadia mira*
32	*Bacidina apiahica*	115	*Fellhanera stanhopeae*	198	*Pyrenidium santessonii*
33	*Bacidina aff. apiahica*	116	*Fellhanera aff. stanhopeae*	199	*Pyrenidium zamiae*
34	*Bacidina mirabilis*	117	*Fellhanera subfuscatula*	200	*Sporopodium antonianum*
35	*Badimia dimidiata*	118	*Fellhanera sublecanorina*	201	*Sporopodium citrinum*
36	*Badimia galbinea*	119	*Fellhanera verrucifera*	202	*Sporopodium leprieurii*
37	*Badimia polillensis*	120	*Flavobathelium epiphyllum*	203	*Sporopodium phyllocharis*
38	*Badimia subelegans*	121	*Gyalectidium filicinum*	204	*Sporopodium xantholeucum*
39	*Bapalmuia cf. marginalis*	122	*Gyalectidium imperfectum*	205	*Strigula antillarum*
40	*Bapalmuia palmularis*	123	*Gyalideopsis cochlearifera*	206	*Strigula concreta*
41	*Bapalmuia verrucosa*	124	*Gyalideopsis aff. intermedia*	207	*Strigula janeirensis*
42	*Bapalmuia sp.n.*	125	*Gyalideopsis rubescens*	208	*Strigula macrocarpa*
43	*Byssolecania deplanata*	126	*Gyalideopsis vulgaris*	209	*Strigula maculata*
44	*Byssolecania fumosonigricans*	127	*Hemigrapha cf. phaeospora*	210	*Strigula melanobapha*
45	*Byssolecania aff. fumosonigricans*	128	*Keratosphaera batistae*	211	*Strigula microspora*
46	*Byssoloma absconditum*	129	*Lasioloma arachnoideum*	212	*Strigula multipunctata*
47	*Byssoloma amazonicum*	130	*Lichenopeltella epiphylla*	213	*Strigula nemathora*

48	*Byssoloma anomalum*	131	*Loflammia flammea*	214	*Strigula nitidula*
49	*Byssoloma chlorinum*	132	*Loflammia gabrielis*	215	*Strigula obducta*
50	*Byssoloma discordans*	133	Genus et sp.n. aff. *Loflammia*	216	*Strigula phyllogena*
51	*Byssoloma guttiferae*	134	*Logilvia gilva*	217	*Strigula platypoda*
52	*Byssoloma leucoblepharum*	135	*Mazosia bambusae*	218	*Strigula prasina*
53	*Byssoloma lueckingii*	136	*Mazosia dispersa*	219	*Strigula schizospora*
54	*Byssoloma minutissimum*	137	*Mazosia longispora*	220	*Strigula smaragdula*
55	*Byssoloma subdiscordans*	138	*Mazosia melanophthalma*	221	*Strigula subtilissima*
56	*Byssoloma tricholomum*	139	*Mazosia paupercula*	222	*Strigula viridis*
57	*Byssoloma vezdanum*	140	*Mazosia phyllosema*	223	*Tapellaria epiphylla*
58	*Byssoloma wettsteinii*	141	*Mazosia pilosa*	224	*Tapellaria maior*
59	*Calenia conspersa*	142	*Mazosia praemorsa*	225	*Tapellaria nana*
60	*Calenia depressa*	143	*Mazosia pseudobambusae*	226	*Tapellaria puiggarii*
61	*Calenia graphidea*	144	*Mazosia rotula*	227	*Tricharia albostrigosa*
62	*Calenia lobulata*	145	*Mazosia rubropunctata*	228	*Tricharia amazonum*
63	*Calenia phyllogena*	146	*Mazosia tenuissima*	229	*Tricharia couepiae*
64	*Calenia submuralis*	147	*Mazosia tumidula*	230	*Tricharia farinosa*
65	*Calenia thelotremella*	148	*Microtheliopsis uleana*	231	*Tricharia helminthospora*
66	*Calenia triseptata*	149	*Musaespora kalbii*	232	*Tricharia heterella*
67	*Caleniopsis laevigata*	150	*Opegrapha epiporina*	233	*Tricharia hyalina*
68	*Calopadia fusca*	151	*Opegrapha filicina*	234	*Tricharia lancicarpa*
69	*Calopadia pauciseptata*	152	*Opegrapha cf. kalbii*	235	*Tricharia planicarpa*
70	*Calopadia phyllogena*	153	*Opegrapha lambinonii*	236	*Tricharia pseudosantessonii*
71	*Calopadia puiggarii*	154	*Opegrapha matzeri*	237	*Tricharia urceolata*
72	*Calopadia subcoerulescens*	155	*Opegrapha porinicola*	238	*Tricharia vainioi*
73	*Caprettia amazonensis*	156	*Opegrapha sipmanii*	239	*Trichothelium alboatrum*
74	*Caprettia* sp.n.	157	*Opegrapha strigulae*	240	*Trichothelium annulatum*
75	*Chroodiscus australiensis*	158	*Opegrapha uniseptata*	241	*Trichothelium argenteum*
76	*Chroodiscus coccineus*	159	*Opegrapha velata*	242	*Trichothelium bipindense*
77	*Chroodiscus aff. mirificus*	160	*Parmeliella* sp. A.	243	*Trichothelium epiphyllum*
78	*Coccocarpia domingensis*	161	*Parmeliella* sp. B.	244	*Trichothelium juruense*
79	*Coccocarpia palmicola*	162	*Phyllobathelium epiphyllum*	245	*Trichothelium minutum*
80	*Coccocarpia pellita*	163	*Phyllobathelium leguminosae*	246	*Trichothelium mirum*
81	*Coenogonium interpositum*	164	*Phyllobathelium thaxteri*	247	*Trichothelium pallescens*
82	*Coenogonium linkii*	165	*Phyllobathelium* sp.n.	248	*Trichothelium sipmanii*
83	*Cryptothecia candida*	166	*Phyllophiale alba*	249	*Woessia pseudohyphophorifera*

Asta *et al*. (2002) used lichen diversity as an indication of environmental quality in his research. The study discovered that the sum of the overall frequencies of lichen species inside the sampling grid of 10 units positioned on the trunks of free-standing trees had the strongest association. The Influence of Tree Size and Species on Lichen Abundance, Diversity, and Richness in a Northern Hardwood Forest was also investigated by Logsdon & Carson (2010). According to the findings, there are considerable differences in lichen diversity between tree species, with sugar maples having the most diversity when compared to aspen or birch trees. Several different lichen genera were detected more frequently on one (1) tree species than on others, according to the study.

In a study carried out in South America by Flakus et al. (2011), *Lepraria* (*Stereocaulaceae*, lichenized Ascomycota) new species and records were documented. Two (2) new corticolous lichen species were discovered during the study: *Lepraria nothofagi* from Argentina and *L. stephaniana* from a pre-Andean Amazon forest in Bolivia. The study also offers fresh information on sixteen (16) South American *Lepraria* species. The Southern Hemisphere has never seen *Lepraria adhaerens* and *L. diffusa*; South America has never seen *L. borealis*; Chile, Colombia, Peru, and Venezuela have never seen *L. alpina*; Venezuela has never seen *L. caesioalba* (chemo type I); Argentina has never seen *L. lobificans*; Peru has never seen *L. pallida*; and Bolivia and Chile have never seen *L. sipmaniana*. The *L. membranacea* records found in Chile looked to be *L. sipmaniana* records. As a result, there are presently 27 species of *Lepraria spp*. that are now known from South America.

Van den Boom and Sipman conducted a comprehensive investigation on Foliicolous lichens in Suriname and Guyana in 2014, resulting in three (3) new species and new records. The first author sampled foliicolous lichens in Suriname in 2014, yielding one hundred and three (103) records of lichenized and lichenicolous fungus for Suriname, including 89 first records for the country and one (1) remarkable undescribed lichen species (Table 2).

Following that, the second author conducted fieldwork in Guyana in 1992 and again in 1997, yielding twenty-nine (29) new records, including a new chemical strain for *Loflammea epiphylla* and two (2) undescribed lichen species (Table 3). In addition, the new species *Calenia surinamensis*, *Enterographa paruimae*, and *Strigula transversoundulata* are completely described, and a comprehensive list for Suriname (130 taxa) is offered, as well as the additions for Guyana.

Table 2 Checklist of new records of foliicolous lichens and their lichenicolous fungi that was collected in Guyana by Pieter P. G. van den Boom & Harrie J. M. Sipman in 2014

No.	Lichen species	No.	Lichen species	No.	Lichen species
1	*Aspidothelium papillicarpum*	11	*Fellhanera ruida*	21	*Porina tetracerae*
2	*Bacidina defecta*	12	*Graphis furcata*	22	*Strigula transversoundulata*
3	*Bacidina simplex*	13	*Loflammia epiphylla*	23	*Strigula nigrocarpa*
4	*Byssolecania hymenocarpa*	14	*Lyromma confusum*	24	*Tapellaria nigrata*
5	*Byssoloma humboldtianum*	15	*Lyromma dolicobelum*	25	*Tapellariopsis octomera*
6	*Byssoloma hypophyllum*	16	*Malmidea gyalectoides*	26	*Tricharia longispora*
7	*Cryptothecia effusa*	17	*Mazosia conica*	27	*Trichothelium pallidisetum*
8	*Enterographa paruimae*	18	*Mazosia uniseptata*	28	*Epibryon lichenicola*
9	*Eschatogonia dissecta*	19	*Porina Moralesiae*	29	*Hemigrapha strigulae*
10	*Fellhanera punctata*	20	*Porina rubescens*	----	----------------------------

The diversity of lichen species on fruit trees (*Malus sp*., *Pyrus sp*., *Prunus sp*., and *Cerasus sp*.) growing in orchards in particular villages and towns was examined by Matwiejuk (2017). The findings of this study identified 56 species of lichens. Common lichens from the genera *Physcia* and *Phaeophyscia* that grow on the bark of trees in populated regions predominated on the trees, with heliophilous and nitrophilous species dominating. Pear trees and apple trees both have a richer lichen biota (52 species combined) (36). 78% of the biota of this phorophyte growing in Polish fruit orchards are apple tree lichens.

Table 3 Checklist of foliicolous lichens and their lichenicolous fungi that was collected in Suriname by Pieter P. G. van den Boom & Harrie J. M. Sipman in 2014

No.	Lichen species	No.	Lichen species	No.	Lichen species
1	*Actinoplaca strigulacea*	39	*Chroodiscus neotropicus*	77	*Porina fusca*
2	*Anisomeridium foliicola*	40	*Coenogonium barbatum*	78	*Porina leptosperma*
3	*Arthonia aciniformis*	41	*Coenogonium ciliatum*	79	*Porina lucida*
4	*Arthonia cyanea*	42	*Coenogonium dilucidum*	80	*Porina nitidula*
5	*Arthonia lecythidicola*	43	*Coenogonium hypophyllum*	81	*Porina octomera*
6	*Aspidothelium geminiparum*	44	*Coenogonium lisowskii*	82	*Porina radiata*
7	*Aspidothelium scutellicarpum*	45	*Coenogonium siquirrense*	83	*Porina rubentior*
8	*Asterothyrium monosporum*	46	*Coenogonium subluteum*	84	*Porina subepiphylla*
9	*Asterothyrium pittieri*	47	*Echinoplaca epiphylla*	85	*Porina tetramera*
10	*Asterothyrium tetrasporum*	48	*Echinoplaca handelii*	86	*Sporopodium antonianum*
11	*Asterothyrium uniseptatum*	49	*Echinoplaca leucotrichoides*	87	*Sporopodium citrinum*
12	*Aulaxina minuta*	50	*Fellhanera bouteillei*	88	*Sporopodium leprierii*
13	*Aulaxina quadrangula*	51	*Fellhanera flavostanhopeae*	89	*Strigula antillarum*
14	*Bacidina Aapiahica*	52	*Fellhanera fuscatula*	90	*Strigula concreta*
15	*Bacidina hypophylla*	53	*Fellhanera rhaphidophylli*	91	*Strigula maculata*
16	*Bacidina neotropica*	54	*Fellhanera stanhopeae*	92	*Strigula microspora*
17	*Badimia dimidiata*	55	*Fellhanera subfuscatula*	93	*Strigula nemathora*
18	*Bapalmuia palmularis*	56	*Fellhanera verrucifera*	94	*Strigula nitidula*
19	*Brasilicia brasiliensis*	57	*Flavobathelium epiphyllum*	95	*Strigula obducta*
20	*Byssoloma aurantiacum*	58	*Gyalectidium filicinum*	96	*Strigula orbicularis*
21	*Byssoloma citricola*	59	*Gyalideopsis lobulata*	97	*Strigula phyllogena*
22	*Byssoloma leucoblepharum*	60	*Lasioloma arachnoideum*	98	*Strigula platypoda*
23	*Byssoloma minutissimum*	61	*Lyromma ornatum*	99	*Strigula schizospora*
24	*Byssoloma subdiscordans*	62	*Mazosia dispersa*	100	*Strigula smaragdula*
25	*Byssoloma tricholomum*	63	*Mazosia melanopthalma*	101	*Strigula subelegans*
26	*Calenia depressa*	64	*Mazosia phyllosema*	102	*Strigula subtilissima*
27	*Calenia dictyospora*	65	*Mazosia praemorsa*	103	*Tapellaria major*
28	*Calenia surinamensis*	66	*Mazosia rotula*	104	*Tapellariopsis octomera*
29	*Calenia triseptata*	67	*Opegrapha filicina*	105	*Tricharia urceolata*
30	*Caleniopsis conspersa*	68	*Phyllobathelium anomalum*	106	*Tricharia vainioi*
31	*Calopadia foliicola*	69	*Phyllobathelium firmum*	107	*Trichothelium bipindense*
32	*Calopadia fusca*	70	*Phyllobathelium leguminosae*	108	*Trichothelium juruense*
33	*Calopadia perpallida*	71	*Phyllobathelium thaxteri*	109	*Trichothelium minus*
34	*Calopadia phyllogena*	72	*Porina alba*	110	*Trichothelium minutum*
35	*Calopadia puiggarii*	73	*Porina atrocoerulea*	111	*Trichothelium pallescens*

36	*Calopadia subcoerulescens*	74	*Porina distans*	112	*Trichothelium pallidisetum*
37	*Chroodiscus australiensis*	75	*Porina epiphylla*	113	*Keratosphaera dimerella*
38	*Chroodiscus coccineus*	76	*Porina fulvella*	114	*Opegrapha phylloporinae*

Table 4 Species frequency distributed over each site sampled, overall urban site, overall suburban site & overall New Amsterdam

Family	**Species**	**Site #1**	**Site #2**	**Site #3**	**Site #4**	**Suburban (Site #3&4)**	**Urban (Site #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

(Result above Adopted from Bacchus & Da Silva, 2021)

Vondrak *et al*. investigated hotspots and effective lichen diversity determination in a forest in 2018. They found alpha-diversities ranging from 181– 228 species. In addition, three hundred eighty-seven (387) species of gamma-diversity were discovered, with estimation ranging from four hundred nine to four hundred eighty-four (409–484) species. Muggia & Grube (2018) looked at lichen fungal diversity from extreme tolerance to interactions with algae. Based oon the results from this study, it was noted that chemical and genetic variety, as well as some evolutionary processes, led to the diversification of symptomatic and asymptomatic lichenicolous fungi. Roper (2018) then did a study on Lichen Abundance and Diversity in Relation to Host Tree Species and Lakeshore Proximity in Michigan. When compared to lakeshore proximity, tree species was a far larger impact in epiphytic lichen diversity and abundance, according to the findings of this study.

Rashmi and Rajkumar (2019) conducted another study in which they evaluated the diversity of lichens along elevational gradients in forest ranges. A total of 97 lichens were discovered throughout the survey, belonging to 47 genera and 25 families. It was also reported in this study that, as one approaches the elevation of the mountain summit, lichens become more abundant, dense, and widely scattered as the land gradient increases.

In addition, Giordani (2019) did another study in which they analyzed lichen diversity and biomonitoring. It was found that the more diversified and structurally complex the flora is, the more diverse the lichen communities are. The study also identified new opportunities for better lichen conservation strategies. Huang *et al*. (2019) investigated how rapid diversifications in three (3) different groups of morphologically sophisticated lichen-forming fungi are linked to key historical events. The findings reveal diversification events in three (3) families from the subclass Lecanoromycetidae, largely constituted of macro lichens that build three-dimensional structures: Cladoniaceae, Parmeliaceae, and Peltigeraceae.

Brazilian lichenicolous fungi *Cryptodiscus gassicurtiae* on *Gassicurtia coccinea* from Alagoas and *Stigmidium anguinellicola* on *Nyungwea anguinella* from Sergipe were both described as being novel to science by Etayo *et al.* (2020). For the first time, nine (9) lichenicolous fungi from Brazil have been discovered (or from South America). The seventy-eight (78) lichenicolous fungi was previously reported from Brazil are listed in annotated form.

In addition, Bacchus and Da Silva (2021) examined the diversity of corticolous lichens in urban and suburban settings in New Amsterdam, Berbice, Guyana. Five (5) different species of trees were sampled. A total of 41 trees were sampled in this study, with 14978 unique lichens identified from ten (10) families, thirteen (13) genera, and eighteen (18) species (Table 4). The study's findings included a checklist of New Amsterdam's corticolous lichen species, as well as the conclusion that urban corticolous lichens exhibit higher species richness, species evenness, and alpha diversity than the suburban corticolous lichen community.

Table 5 Integrated checklist of lichen species and their distribution in the Neotropics

No	Families	Lichen species	Distribution	Author(s)
1	Gomphillace ae	*Actinoplaca strigulacea*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
2	Stereocaulaceae	*Lepraria adhaerens*	Peru	(Knudsen et al., 2007)
3	Parmulariaceae	*Hemigrapha asteriscus*	Brazil	(Aptroop, 2002)
4	Stereocaulaceae	*Lepraria yunnaniana*	Costa Rica, Bolivia, Ecuador, Columbia	(Aptroot et al., 1997), (Aptroot & Feijen 2002), (Kukwa, 2006), (Elix, 2006), (Elix, 2009), (Nöske et al., 2007), (Laundon, 2008), (Nelsen & Gargas, 2008), (Kukwa & Flakus 2009)
5	Mycocaliciaceae	*Mycocalicium enterographicola*	Brazil	(Aptroot et al., 2016)
6	Arthoniaceae	*Arthonia tavaresii*	Brazil	(Aptroot, 2002)
7	Cladoniaceae	*Phaeopyxis punctum*	Brazil	(Aptroot, 2002)

8	Tremellaceae	*Tremella lobariacearum*	Brazil	(Aptroot, 2002)
9	Arthoniaceae	*Arthonia cinnabarina*	Guyana	(Bacchus & Da Silva, 2021)
10	Arthoniaceae	*Arthonia pruinata*	Guyana	(Bacchus & Da Silva, 2021)
11	Arthoniaceae	*Arthonia radiata*	Guyana	(Bacchus & Da Silva, 2021)
12	Ramalinaceae	*Bacidia laurocerasi*	Guyana	(Bacchus & Da Silva, 2021)
13	Monoblastiaceae	*Anisomeridium biforme*	Guyana	(Bacchus & Da Silva, 2021)
14	Cladoniaceae	*Cladonia parasitica*	Guyana	(Bacchus & Da Silva, 2021)
15	Collemataceae	*Collema furfuraceum*	Guyana	(Bacchus & Da Silva, 2021)
16	Coenogoniaceae	*Dimerella lutea*	Guyana	(Bacchus & Da Silva, 2021)
17	Caliciaceae	*Dirinaria applanata*	Guyana	(Bacchus & Da Silva, 2021)
18	Parmeliaceae	*Flavoparmelia caperata*	Guyana	(Bacchus & Da Silva, 2021)
19	Parmeliaceae	*Flavoparmelia soredians*	Guyana	(Bacchus & Da Silva, 2021)
20	Parmeliaceae	*Hypotrachyna laevigata*	Guyana	(Bacchus & Da Silva, 2021)
21	Bulleraceae	*Biatoropsis usnearum*	Brazil	(Brackel, 2014)
22	Sphinctrinaceae	*Sphinctrina tubaeformis*	Brazil	(Caceres, 2007), (Spielmann, 2006), (Tibell, 1996)
23	Dacampiaceae	*Pyrenidium zamiae*	Brazil, Guyana	(Cengia, 1940), (Lucking, 1996), (Matzer, 1996), (Lucking & Klab, 2000)
24	Arthoniaceae	*Labrocarpon canariensis*	Brazil	(Diderich, 2003), (Ertz & Diderich, 2015)
25	Cordieritidaceae	*Diplolaeviopsis ranuola*	Brazil	(Diederich, 2003)
26	Enterococcaceae	*Endococcus apiciicola*	Brazil	(Diederich, 2003)
27	Roccellaceae	*Opegrapha melanospila*	Brazil	(Diederich, 2003)
28	Tremellaceae	*Tremella parmeliarum*	Brazil	(Diedrich, 1996), (Diedrich, 2003)
29	Tremellaceae	*Tremella leptogii*	Brazil	(Diedrich, 2003)
30	Tremellaceae	*Tremella stictae*	Brazil	(Diedrich, 2003)
31	Nectriaceae	*Xenonectriella streimannii*	Brazil	(Diedrich, 2003)
32	Stereocaulaceae	*Lepraria borealis*	Chile	(Ekman & Tønsberg, 2002), (Tønsberg, 2004),

				(Kukwa, 2006), (Slaviková-Bayerová & Fehrer, 2007), (Saag et al., 2009)
33	Schaereriaceae	*Buelliella minimula*	Brazil	(Ertz & Diederich, 2015)
34	Hyponectriaceae	*Lichenoverruculina sigmatospora*	Brazil	(Etayo & Rosato, 2008), (Etayo & Sharuddin, 2011)
35	Physciaceae	*Buelliella minimul*	Brazil, Ecuador	(Etayo et al., 2020)
36	Parmeliaceae	*Cryptodiscus gassicurtiae*	Brazil	(Etayo et al., 2020)
37	Hypocreaceae	*Dialhypocrea puiggariana*	Brazil	(Etayo et al., 2020)
38	Melaspileaceae	*Melanographa tribuloides*	Brazil	(Etayo et al., 2020)
39	Rosaceae	*Minutoexcipula tuckerae*	Brazil	(Etayo et al., 2020)
40	Mycosphaerellaceae	*Stigmidium anguinellicola*	Brazil	(Etayo et al., 2020)
41	Mycosphaerellaceae	*Stigmidium epixanthum*	Brazil, Venezuela	(Etayo et al., 2020)
42	Tremellaceae	*Tremella cladoniae*	Bolivia,Brazil, Colombia, Ecuador	(Etayo et al., 2020)
43	Xanthopyreniaceae	*Zwackhiomyces cladoniae*	Brazil	(Etayo et al., 2020)
44	Abrothallaceae	*Abrothallus hypotrachynae*	Brazil	(Etayo, 2002)
45	Polycoccaceae	*Polycoccum dictyonematis*	Brazil	(Etayo, 2010)
46	Arthoniaceae	*Arthonia subconveniens*	Brazil	(Etayo, 2017)
47	Verrucariaceae	*Rosellinula lopadii*	Brazil	(Etayo, 2017)
48	Phaeococcomycetaceae	*Etayoa trypethelii*	Brazil, Ecuador	(Etayo, 2017), (Etayo et al., 2020)
49	Bionectriaceae	*Ovicuculispora parmeliae*	Brazil	(Farr, 1973), (Etayo & Rosato, 2008)
50	Stereocaulaceae	*Lepraria incana*	Bolivia, Colombia, Chile	(Flakus & Kukwa 2007), (Sipman et al., 2008)
51	Stereocaulaceae	*Lepraria nothofagi*	Argentina	(Flakus & Kukwa, 2007)
52	Stereocaulaceae	*Lepraria squamatica*	Bolivia, Peru	(Flakus & Kukwa, 2007)
53	Stereocaulaceae	*Lepraria stephaniana*	Bolivia	(Flakus & Kukwa, 2007)

54	Stereocaulaceae	*Lepraria achariana*	Bolivia	(Flakus & Kukwa, 2007), (Knudsen et al., 2007)
55	Odontellidae	*Leightoniomyces phillipsii*	Brazil	(Grandi, 2012)
56	Arthoniaceae	*Arthonia haematostigma*	Brazil	(Grube et al., 1995)
57	Arthoniaceae	*Helicobolomyces lichenicola*	Brazil	(Grube et al., 1995)
58	Phaeococcomycetaceae	*Lichenostigma cosmopolites*	Brazil	(Hafellner & Calatayud, 1999)
59	Sarcopyreniaceae	*Roselliniella kalbii*	Brazil	(Hafellner, 1985)
60	Mytilinidiaceae	*Taeniolella serusiauxii*	Brazil	(Heuchert et al.,2018)
61	Stereocaulaceae	*Lepraria ecorticata*	Bolivia, Brazil, Chile, Peru	(Kukwa, 2006), (Flakus & Kukwa, 2007)
62	Stereocaulaceae	*Lepraria vouauxii*	Bolivia, Chile, Ecuador, Peru	(Laundon, 1989), (Leuckert & Kümmerling, 1991), (Tønsberg, 1992), (Tønsberg, 2004), (Kukwa & Flakus, 2009), (Elix, 2009)
63	Mycosphaerellaceae	*Stigmidium allogenum*	Brazil	(Leighton, 1866)
64	Stereocaulaceae	*Lepraria membranacea*	Argentina	(Leuckert & Kümmerling, 1991)
65	Stereocaulaceae	*Lepraria sipmaniana*	Bolivia, Brazil, Chile, Columbia, Peru	(Leuckert & Kümmerling, 1991), (Flakus & Kukwa, 2007)
66	Arthoniaceae	*Arthonia orbygniae*	Brazil	(Lucking & Kalb, 2000)
67	Arthoniaceae	*Arthonia santessonii*	Brazil	(Lucking & Kalb, 2000)
68	Roccellaceae	*Mazosiaadelphoparasitica*	Brazil	(Lucking & Klab, 2000)
69	Trichotheliaceae	*Keratosphaera furcatiseta*	Brazil	(Lucking et al., 1999)
70	Parmeliaceae	*Vouauxiella pithospora*	Brazil	(Lucking et al., 1999)
71	Parmulariaceae	*Hemigrapha pilocarpacearum*	Brazil	(Lucking et al., 1999), (Lucking & Klab, 2000)
72	Ramalinaceae	*Bacidia brasiliensis*	Guyana	(Lucking, 1966)
73	Ramalinaceae	*Bacidia cf. corallifera*	Guyana	(Lucking, 1966)
74	Ramalinaceae	*Bacidia psychotriae*	Guyana	(Lucking, 1966)

75	Ramalinaceae	*Bacidina apiahica*	Guyana	(Lucking, 1966)
76	Ramalinaceae	*Bacidina aff. apiahica*	Guyana	(Lucking, 1966)
77	Ramalinaceae	*Bacidina mirabilis*	Guyana	(Lucking, 1966)
78	Roccellaceae	*Mazosia dispersa*	Guyana, Suriname	(Lucking, 1966), (van den Boom & Sipman, 2014)
79	Roccellaceae	*Mazosia melanophthalma*	Guyana, Suriname	(Lucking, 1966), (van den Boom & Sipman, 2014)
80	Roccellaceae	*Mazosia phyllosema*	Guyana Suriname	(Lucking, 1966), (van den Boom & Sipman, 2014)
81	Roccellaceae	*Mazosia praemorsa*	Guyana Suriname	(Lucking, 1966), (van den Boom & Sipman, 2014)
82	Arthoniaceae	*Amazonomyces sprucei*	Guyana	(Lucking, 1996)
83	Monoblastiaceae	*Anisomeridium musaesporoides*	Guyana	(Lucking, 1996)
84	Arthoniaceae	*Arthonia accolens*	Guyana	(Lucking, 1996)
85	Arthoniaceae	*Arthonia atropunctata*	Guyana	(Lucking, 1996)
86	Arthoniaceae	*Arthonia flavoverrucosa*	Guyana	(Lucking, 1996)
87	Arthoniaceae	*Arthonia grubei*	Guyana	(Lucking, 1996)
88	Arthoniaceae	*Arthonia leptosperma*	Guyana	(Lucking, 1996)
89	Arthoniaceae	*Arthonia mira*	Guyana	(Lucking, 1996)
90	Arthoniaceae	*Arthonia palmulacea*	Guyana	(Lucking, 1996)
91	Arthoniaceae	*Arthonia pseudopegraphina*	Guyana	(Lucking, 1996)
92	Arthoniaceae	*Arthonia trilocularis*	Guyana	(Lucking, 1996)
93	Gomphillaceae	*Aulaxina aff. epiphylla*	Guyana	(Lucking, 1996)
94	Gomphillaceae	*Aulaxina intermedia*	Guyana	(Lucking, 1996)
95	Gomphillaceae	*Aulaxina microphana*	Guyana	(Lucking, 1996)
96	Gomphillaceae	*Aulaxina opegraphina*	Guyana	(Lucking, 1996)
97	Pilocarpaceae	*Bapalmuia cf. marginalis*	Guyana	(Lucking, 1996)

98	Pilocarpaceae	*Bapalmuia verrucosa*	Guyana	(Lucking, 1996)
99	Pilocarpaceae	*Bapalmuia sp.n.*	Guyana	(Lucking, 1996)
100	Pilocarpaceae	*Byssolecania deplanata*	Guyana	(Lucking, 1996)
101	Pilocarpaceae	*Byssolecania fumosonigricans*	Guyana	(Lucking, 1996)
102	Pilocarpaceae	*Byssolecania aff. fumosonigricans*	Guyana	(Lucking, 1996)
103	Pilocarpaceae	*Byssoloma absconditum*	Guyana	(Lucking, 1996)
104	Pilocarpaceae	*Byssoloma amazonicum*	Guyana	(Lucking, 1996)
105	Pilocarpaceae	*Byssoloma anomalum*	Guyana	(Lucking, 1996)
106	Pilocarpaceae	*Byssoloma chlorinum*	Guyana	(Lucking, 1996)
107	Pilocarpaceae	*Byssoloma discordans*	Guyana	(Lucking, 1996)
108	Pilocarpaceae	*Byssoloma guttiferae*	Guyana	(Lucking, 1996)
109	Pilocarpaceae	*Byssoloma lueckingii*	Guyana	(Lucking, 1996)
110	Pilocarpaceae	*Byssoloma vezdanum*	Guyana	(Lucking, 1996)
111	Pilocarpaceae	*Byssoloma wettsteinii*	Guyana	(Lucking, 1996)
112	Gomphillaceae	*Calenia conspersa*	Guyana	(Lucking, 1996)
113	Gomphillaceae	*Calenia graphidea*	Guyana	(Lucking, 1996)
114	Gomphillaceae	*Calenia lobulata*	Guyana	(Lucking, 1996)
115	Gomphillaceae	*Calenia phyllogena*	Guyana	(Lucking, 1996)
116	Gomphillaceae	*Calenia submuralis*	Guyana	(Lucking, 1996)
117	Gomphillaceae	*Calenia thelotremella*	Guyana	(Lucking, 1996)
118	Gomphillaceae	*Caleniopsis laevigata*	Guyana	(Lucking, 1996)
119	Pilocarpaceae	*Calopadia pauciseptata*	Guyana	(Lucking, 1996)
120	Monoblastiaceae	*Caprettia amazonensis*	Guyana	(Lucking, 1996)
121	Monoblastiaceae	*Caprettia sp.n.*	Guyana	(Lucking, 1996)

122	Graphidaceae	*Chroodiscus aff. mirificus*	Guyana	(Lucking, 1996)
123	Coccocarpiaceae	*Coccocarpia domingensis*	Guyana	(Lucking, 1996)
124	Coccocarpiaceae	*Coccocarpia palmicola*	Guyana	(Lucking, 1996)
125	Coccocarpiaceae	*Coccocarpia pellita*	Guyana	(Lucking, 1996)
126	Coenogoniaceae	*Coenogonium interpositum*	Guyana	(Lucking, 1996)
127	Coenogoniaceae	*Coenogonium linkii*	Guyana	(Lucking, 1996)
128	Arthoniaceae	*Cryptothecia candida*	Guyana	(Lucking, 1996)
129	Hygrophoraceae	*Dictyonema phyllogenum*	Guyana	(Lucking, 1996)
130	Coenogoniaceae	*Dimerella epiphylla*	Guyana	(Lucking, 1996)
131	Coenogoniaceae	*Dimerella fallaciosa*	Guyana	(Lucking, 1996)
132	Coenogoniaceae	*Dimerella flavicans*	Guyana	(Lucking, 1996)
133	Coenogoniaceae	*Dimerella hypophylla*	Guyana	(Lucking, 1996)
134	Coenogoniaceae	*Dimerella isidiifera*	Guyana	(Lucking, 1996)
135	Coenogoniaceae	*Dimerella aff. pilifera*	Guyana	(Lucking, 1996)
136	Coenogoniaceae	*Dimerella zonata*	Guyana	(Lucking, 1996)
137	Gomphillaceae	*Echinoplaca diffluens*	Guyana	(Lucking, 1996)
138	Gomphillaceae	*Echinoplaca furcata*	Guyana	(Lucking, 1996)
139	Gomphillaceae	*Echinoplaca fusconitida*	Guyana	(Lucking, 1996)
140	Gomphillaceae	*Echinoplaca aff. fusconitida*	Guyana	(Lucking, 1996)
141	Gomphillaceae	*Echinoplaca hymenocarpoides*	Guyana	(Lucking, 1996)
142	Gomphillaceae	*Echinoplaca aff. incrustatociliata*	Guyana	(Lucking, 1996)
143	Gomphillaceae	*Echinoplaca marginata*	Guyana	(Lucking, 1996)
144	Gomphillaceae	*Echinoplaca pellicula*	Guyana	(Lucking, 1996)

145	Gomphillaceae	*Echinoplaca serusiauxii*	Guyana	(Lucking, 1996)
146	Gomphillaceae	*Echinoplaca tricharioides*	Guyana	(Lucking, 1996)
147	Gomphillaceae	*Echinoplaca verrucifera*	Guyana	(Lucking, 1996)
148	Arthoniaceae	*Eremothecella calamicola*	Guyana	(Lucking, 1996)
149	Pilocarpaceae	*Fellhanera angustispora*	Guyana	(Lucking, 1996)
150	Pilocarpaceae	*Fellhanera badimioides*	Guyana	(Lucking, 1996)
151	Pilocarpaceae	*Fellhanera cf. dispersa*	Guyana	(Lucking, 1996)
152	Pilocarpaceae	*Fellhanera emarginata*	Guyana	(Lucking, 1996)
153	Pilocarpaceae	*Fellhanera lisowskii*	Guyana	(Lucking, 1996)
154	Pilocarpaceae	*Fellhanera rhapidophylli*	Guyana	(Lucking, 1996)
155	Pilocarpaceae	*Fellhanera santessonii*	Guyana	(Lucking, 1996)
156	Pilocarpaceae	*Fellhanera aff. stanhopeae*	Guyana	(Lucking, 1996)
157	Pilocarpaceae	*Fellhanera sublecanorina*	Guyana	(Lucking, 1996)
158	Gomphillaceae	*Gyalectidium imperfectum*	Guyana	(Lucking, 1996)
159	Gomphillaceae	*Gyalideopsis cochlearifera*	Guyana	(Lucking, 1996)
160	Gomphillaceae	*Gyalideopsis aff. intermedia*	Guyana	(Lucking, 1996)
162	Gomphillaceae	*Gyalideopsis rubescens*	Guyana	(Lucking, 1996)
163	Gomphillaceae	*Gyalideopsis vulgaris*	Guyana	(Lucking, 1996)
164	Parmulariaceae	*Hemigrapha cf. phaeospora*	Guyana	(Lucking, 1996)
165	Pilocarpaceae	*Loflammia flammea*	Guyana	(Lucking, 1996)
166	Pilocarpaceae	*Loflammia gabrielis*	Guyana	(Lucking, 1996)
167	Pilocarpaceae	*Genus et sp.n. aff. Loflammia*	Guyana	(Lucking, 1996)
168	Pilocarpaceae	*Logilvia gilva*	Guyana	(Lucking, 1996)

169	Roccellaceae	*Mazosia bambusae*	Guyana	(Lucking, 1996)
170	Roccellaceae	*Mazosia longispora*	Guyana	(Lucking, 1996)
171	Roccellaceae	*Mazosia paupercula*	Guyana	(Lucking, 1996)
172	Roccellaceae	*Mazosia pilosa*	Guyana	(Lucking, 1996)
173	Roccellaceae	*Mazosia pseudobambusae*	Guyana	(Lucking, 1996)
174	Roccellaceae	*Mazosia rotula*	Guyana	(Lucking, 1996)
175	Roccellaceae	*Mazosia rubropunctata*	Guyana	(Lucking, 1996)
176	Roccellaceae	*Mazosia tenuissima*	Guyana	(Lucking, 1996)
177	Roccellaceae	*Mazosia tumidula*	Guyana	(Lucking, 1996)
178	Microtheliopsidaceae	*Microtheliopsis uleana*	Guyana	(Lucking, 1996)
179	Monoblastiaceae	*Musaespora kalbii*	Guyana	(Lucking, 1996)
180	Roccellaceae	*Opegrapha cf. kalbii*	Guyana	(Lucking, 1996)
181	Roccellaceae	*Opegrapha lambinonii*	Guyana	(Lucking, 1996)
182	Roccellaceae	*Opegrapha porinicola*	Guyana	(Lucking, 1996)
183	Roccellaceae	*Opegrapha uniseptata*	Guyana	(Lucking, 1996)
184	Pannariaceae	*Parmeliella sp. A.*	Guyana	(Lucking, 1996)
185	Pannariaceae	*Parmeliella sp. B.*	Guyana	(Lucking, 1996)
186	Phyllobatheliaceae	*Phyllobathelium epiphyllum*	Guyana	(Lucking, 1996)
187	Phyllobatheliaceae	*Phyllobathelium sp.n.*	Guyana	(Lucking, 1996)
188	Pertusariaceae	*Phyllophiale aff. alba*	Guyana	(Lucking, 1996)
189	Pertusariaceae	*Phyllophiale fusca*	Guyana	(Lucking, 1996)
190	Trichotheliaceae	*Porina andreana*	Guyana	(Lucking, 1996)
191	Trichotheliaceae	*Porina atriceps*	Guyana	(Lucking, 1996)
192	Trichotheliaceae	*Porina atropunctata*	Guyana	(Lucking, 1996)
193	Trichotheliaceae	*Porina curtula*	Guyana	(Lucking, 1996)
194	Trichotheliaceae	*Porina epilucida*	Guyana	(Lucking, 1996)

195	Trichotheliaceae	*Porina guianensis*	Guyana	(Lucking, 1996)
196	Trichotheliaceae	*Porina imitatrix*	Guyana	(Lucking, 1996)
197	Trichotheliaceae	*Porina leptospermoides*	Guyana	(Lucking, 1996)
198	Trichotheliaceae	*Porina limbulata*	Guyana	(Lucking, 1996)
199	Trichotheliaceae	*Porina mirabilis*	Guyana	(Lucking, 1996)
200	Trichotheliaceae	*Porina aff. mirabilis*	Guyana	(Lucking, 1996)
201	Trichotheliaceae	*Porina nucula*	Guyana	(Lucking, 1996)
202	Trichotheliaceae	*Porina papillifera*	Guyana	(Lucking, 1996)
203	Trichotheliaceae	*Porina rufula*	Guyana	(Lucking, 1996)
204	Trichotheliaceae	*Porina vezdae*	Guyana	(Lucking, 1996)
205	Pilocarpaceae	*Pseudocalopadia mira*	Guyana	(Lucking, 1996)
206	Pilocarpaceae	*Sporopodium phyllocharis*	Guyana	(Lucking, 1996)
207	Pilocarpaceae	*Sporopodium xantholeucum*	Guyana	(Lucking, 1996)
208	Strigulaceae	*Strigula janeirensis*	Guyana	(Lucking, 1996)
209	Strigulaceae	*Strigula macrocarpa*	Guyana	(Lucking, 1996)
210	Strigulaceae	*Strigula melanobapha*	Guyana	(Lucking, 1996)
211	Strigulaceae	*Strigula prasina*	Guyana	(Lucking, 1996)
212	Strigulaceae	*Strigula viridis*	Guyana	(Lucking, 1996)
213	Pilocarpaceae	*Tapellaria epiphylla*	Guyana	(Lucking, 1996)
214	Pilocarpaceae	*Tapellaria maior*	Guyana	(Lucking, 1996)
215	Pilocarpaceae	*Tapellaria nana*	Guyana	(Lucking, 1996)
216	Pilocarpaceae	*Tapellaria puiggarii*	Guyana	(Lucking, 1996)
217	Gomphillaceae	*Tricharia albostrigosa*	Guyana	(Lucking, 1996)
218	Gomphillaceae	*Tricharia amazonum*	Guyana	(Lucking, 1996)
219	Gomphillaceae	*Tricharia couepiae*	Guyana	(Lucking, 1996)
220	Gomphillaceae	*Tricharia farinosa*	Guyana	(Lucking, 1996)
221	Gomphillaceae	*Tricharia helminthospora*	Guyana	(Lucking, 1996)

222	Gomphillaceae	*Tricharia heterella*	Guyana	(Lucking, 1996)
223	Gomphillaceae	*Tricharia hyalina*	Guyana	(Lucking, 1996)
224	Gomphillaceae	*Tricharia lancicarpa*	Guyana	(Lucking, 1996)
225	Gomphillaceae	*Tricharia planicarpa*	Guyana	(Lucking, 1996)
226	Gomphillaceae	*Tricharia pseudosantessonii*	Guyana	(Lucking, 1996)
227	Trichotheliaceae	*Trichothelium alboatrum*	Guyana	(Lucking, 1996)
228	Trichotheliaceae	*Trichothelium annulatum*	Guyana	(Lucking, 1996)
229	Trichotheliaceae	*Trichothelium argenteum*	Guyana	(Lucking, 1996)
230	Trichotheliaceae	*Trichothelium epiphyllum*	Guyana	(Lucking, 1996)
231	Trichotheliaceae	*Trichothelium mirum*	Guyana	(Lucking, 1996)
232	Trichotheliaceae	*Trichothelium sipmanii*	Guyana	(Lucking, 1996)
233	Ramalinaceae	*Woessia pseudohyphophorifera*	Guyana	(Lucking, 1996)
234	Thelenellaceae	*Aspidothelium fugiens*	Guyana	(Lucking, 1996)
235	Thelenellaceae	*Aspidothelium sp.n.*	Guyana	(Lucking, 1996)
236	Gomphillaceae	*Asterothyrium leptosporum*	Guyana	(Lucking, 1996)
237	Gomphillaceae	*Asterothyrium leucophthalmum*	Guyana	(Lucking, 1996)
238	Gomphillaceae	*Asterothyrium aff. monosporum*	Guyana	(Lucking, 1996)
239	Ramalinaceae	*Badimia galbinea*	Guyana	(Lucking, 1996)
240	Ramalinaceae	*Badimia polillensis*	Guyana	(Lucking, 1996)
241	Ramalinaceae	*Badimia subelegans*	Guyana	(Lucking, 1996)
242	Roccellaceae	*Opegrapha matzeri*	Brazil, Guyana	(Lucking, 1996), (Lucking & Klab, 2000)
243	Dacampiaceae	*Pyrenidium santessonii*	Brazil, Guyana	(Lucking, 1996), (Lucking & Klab, 2000)
244	Roccellaceae	*Opegrapha strigulae*	Brazil, Guyana	(Lucking, 1996),

				(Lucking et al., 1999)
245	Trichotheliaceae	*Keratosphaera batistae*	Brazil, Guyana	(Lucking, 1996), (Matzer, 1996)
246	Microthyriaceae	*Lichenopeltella epiphylla*	Brazil, Guyana	(Lucking, 1996), (Matzer, 1996)
247	Roccellaceae	*Opegrapha sipmanii*	Brazil, Guyana	(Lucking, 1996), (Matzer, 1996)
248	Roccellaceae	*Opegrapha velata*	Brazil, Guyana	(Lucking, 1996), (Matzer, 1996)
249	Arthoniaceae	*Arthonia intermedia*	Brazil, Guyana	(Lucking, 1996), (Matzer, 1996), (Lucking et al., 1999)
250	Gomphillaceae	*Aulaxina minuta*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
251	Gomphillaceae	*Aulaxina quadrangula*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
252	Pilocarpaceae	*Bapalmuia palmularis*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
253	Pilocarpaceae	*Byssoloma leucoblepharum*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
254	Pilocarpaceae	*Byssoloma minutissimum*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
255	Pilocarpaceae	*Byssoloma subdiscordans*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
256	Pilocarpaceae	*Byssoloma tricholomum*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
257	Gomphillaceae	*Calenia depressa*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
258	Gomphillaceae	*Calenia triseptata*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
259	Pilocarpaceae	*Calopadia fusca*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
260	Pilocarpaceae	*Calopadia phyllogena*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
261	Pilocarpaceae	*Calopadia puiggariiJ*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
262	Pilocarpaceae	*Calopadia subcoerulescens*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
263	Graphidaceae	*Chroodiscus australiensis*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
264	Graphidaceae	*Chroodiscus coccineus*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
265	Ramalinaceae	*Badimia dimidiata*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
266	Monoblastiaceae	*Anisomeridium foliicola*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)

267	Arthoniaceae	*Arthonia aciniformis*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
268	Arthoniaceae	*Arthonia cyanea*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
269	Arthoniaceae	*Arthonia lecythidicola*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
270	Gomphillaceae	*Echinoplaca epiphylla*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
271	Gomphillaceae	*Echinoplaca leucotrichoides*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
271	Pilocarpaceae	*Fellhanera bouteillei*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
273	Pilocarpaceae	*Fellhanera fuscatula*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
274	Pilocarpaceae	*Fellhanera stanhopeae*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
275	Pilocarpaceae	*Fellhanera subfuscatula*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
276	Pilocarpaceae	*Fellhanera verrucifera*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
277	Strigulaceae	*Flavobathelium epiphyllum*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
278	Gomphillaceae	*Gyalectidium filicinum*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
279	Pilocarpaceae	*Lasioloma arachnoideum*	Guyana, Brazil	(Lucking, 1996), (van den Boom & Sipman, 2014)
280	Roccellaceae	*Opegrapha filicina*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
281	Phyllobatheliaceae	*Phyllobathelium leguminosae*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
282	Phyllobatheliaceae	*Phyllobathelium thaxteri*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
283	Pertusariaceae	*Phyllophiale alba*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
284	Trichotheliaceae	*Porina atrocoerulea*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
285	Trichotheliaceae	*Porina distans*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
286	Trichotheliaceae	*Porina epiphylla*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
287	Trichotheliaceae	*Porina fulvella*	Guyana, Suriname	(Lucking, 1996),(van den Boom & Sipman, 2014)
288	Trichotheliaceae	*Porina fusca*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
289	Trichotheliaceae	*Porina leptosperma*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)

290	Trichotheliaceae	*Porina lucida*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
291	Trichotheliaceae	*Porina nitidula*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
292	Trichotheliaceae	*Porina octomera*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
293	Trichotheliaceae	*Porina radiata*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
294	Trichotheliaceae	*Porina rubentior*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
295	Trichotheliaceae	*Porina subepiphylla*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
296	Trichotheliaceae	*Porina tetramera*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
297	Pilocarpaceae	*Sporopodium antonianum*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
298	Pilocarpaceae	*Sporopodium citrinum*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
299	Pilocarpaceae	*Sporopodium leprieurii*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
300	Strigulaceae	*Strigula antillarum*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
301	Strigulaceae	*Strigula concreta*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
302	Strigulaceae	*Strigula maculata*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
303	Strigulaceae	*Strigula microspora*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
304	Strigulaceae	*Strigula multipunctata*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
305	Strigulaceae	*Strigula nemathora*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
306	Strigulaceae	*Strigula nitidula*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
307	Strigulaceae	*Strigula obducta*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
308	Strigulaceae	*Strigula phyllogena*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
309	Strigulaceae	*Strigula platypoda*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
310	Strigulaceae	*Strigula schizospora*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
311	Strigulaceae	*Strigula smaragdula*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
312	Strigulaceae	*Strigula subtilissima*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)

313	Gomphillaceae	*Tricharia urceolata*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
314	Gomphillaceae	*Tricharia vainioi*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
315	Trichotheliaceae	*Trichothelium bipindense*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
316	Trichotheliaceae	*Trichothelium juruense*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
317	Trichotheliaceae	*Trichothelium minutum*	Guyana, Suriname	(Lucking, 1996), (van den Boom & Sipman, 2014)
318	Trichotheliaceae	*Trichothelium pallescens*	Guyana, Surinmae	(Lucking, 1996), (van den Boom & Sipman, 2014)
319	Epibryaceae	*Epibryon lichenicola*	Brazil	(Matzer, 1996)
320	Parmulariaceae	*Hemigrapha phaeospora*	Brazil	(Matzer, 1996)
321	Parmulariaceae	*Hemigrapha tenellula*	Brazil	(Matzer, 1996)
322	Trichotheliaceae	*Keratosphaera porinae*	Brazil	(Matzer, 1996)
323	Microthyriaceae	*Lichenopeltella setifera*	Brazil	(Matzer, 1996)
324	Verrucariaceae	*Macentina uniseptata*	Brazil	(Matzer, 1996)
325	Roccellaceae	*Opegrapha phyllobathelii*	Brazil	(Matzer, 1996)
326	Dacampiaceae	*Pyrenidium sporopodiorum*	Brazil	(Matzer, 1996)
327	Mycosphaerellaceae	*Stigmidium epiphyllum*	Brazil	(Matzer, 1996)
328	Parmeliaceae	*Teratoschaeta rondoniensis*	Brazil	(Matzer, 1996)
329	Umbilicariaceae	*Trichophyma bunchosae*	Brazil	(Matzer, 1996)
330	Umbilicariaceae	*Trichophyma similis*	Brazil	(Matzer, 1996)
331	Pseudoperisporiaceae	*Wentiomyces lichenicola*	Brazil	(Matzer, 1996)
332	Roccellaceae	*Opegrapha mazosiae*	Brazil	(Matzer, 1996), (Lucking et al., 1999), (Lucking & Klab, 2000), (Caceres et al., 2014);
333	Arthoniaceae	*Arthonia cinnabarinula*	Brazil	(Matzer, 1996), (Lucking & Kalb, 2000)
334	Roccellaceae	*Opegrapha kalbii*	Brazil	(Matzer, 1996), (Lucking & Klab, 2000)
335	Roccellaceae	*Opegrapha phylloporinae*	Brazil	(Matzer, 1996), (Lucking & Klab, 2000)

336	Mycosphaerellaceae	*Stigmidium calopadiae*	Brazil	(Matzer, 1996), (Lucking & Klab, 2000)
337	Mycosphaerellaceae	*Stigmidium porinae*	Brazil	(Matzer, 1996), (Lucking & Klab, 2000)
338	Arthoniaceae	*Arthonia pseudopegraphina*	Brazil	(Matzer, 1996), (Lucking et al., 1999)
339	Parmulariaceae	*Hemigrapha strigulae*	Brazil, Guyana	(Matzer, 1996), (Lucking et al., 1999), (van den Boom & Sipman, 2014)
340	Roccellaceae	*Opegrapha epiporina*	Brazil, Guyana	(Matzer,1996), (Sparrius, 2004), (Lucking, 1996)
341	Bionectriaceae	*Pronectria subimperspicua*	Brazil	(Motiejunaite & Grochowski, 2014)
342	Spirographaceae	*Spirographa fusisporella*	Brazil	(Muller, 1880)
343	Ramalinaceae	*Scutula cladoniarum*	Brazil	(Muller, 1891)
344	Stereocaulaceae	*Lepraria caesioalba*	Argentina, Bolivia, Colombia, Peru, Venezuela	(Sipman 2004), (Flakus & Kukwa 2007), (Sipman et al., 2008), (Flakus et al., 2011)
345	Stereocaulaceae	*Lepraria pallida*	Bolivia, Brazil, Madagascar	(Sipman, 2004), (Flakus & Kukwa, 2007), (Kukwa & Flakus, 2009)
346	Bionectriaceae	*Nectriopsis lichenophila*	Brazil	(Spegazzini, 1889), (Etayo, 2002)
347	Mycosphaerellaceae	*Stigmidium ramalinae*	Brazil	(Spielmann, 2006)
348	Mycocaliciaceae	*Chaenothecopsis kalbii*	Brazil	(Tibell, 1996)
349	Mycocaliciaceae	*Chaenothecopsis pilosa*	Brazil	(Tibell, 1996)
350	Mycocaliciaceae	*Chaenothecopsis pusilla*	Brazil	(Tibell, 1996)
351	Stereocaulaceae	*Lepraria alpina*	Bolivia, Chile, Colombia, Peru, Venezuela	(Tønsberg, 1992), (Leuckert et al.,1995), (Baruffo et al., 2006), (Flakus & Kukwa, 2007)
352	Stereocaulaceae	*Lepraria lobificans*	Argentina, Bolivia, Chile, Peru	(Tønsberg, 1992), (Tønsberg, 2004), (Sipman, 2004), (Flakus & Kukwa, 2007)
353	Stereocaulaceae	*Lepraria lecanorica*	Chile	(Tønsberg, 2004), (Flakus & Kukwa, 2007)
354	Stereocaulaceae	*Lepraria diffusa*	Bolivia, Ecuador, Peru	(Tønsberg, 2004), (Saag et al., 2009)

355	Parmeliaceae	*Phacopsis oxyspora*	Brazil	(Triebel et al., 1995)
356	Thelenellaceae	*Aspidothelium papillicarpum*	Guyana	(van den Boom & Sipman, 2014)
357	Thelenellaceae	*Aspidothelium geminiparum*	Suriname	(van den Boom & Sipman, 2014)
358	Thelenellaceae	*Aspidothelium scutellicarpum*	Suriname	(van den Boom & Sipman, 2014)
359	Gomphillaceae	*Asterothyrium monosporum*	Suriname	(van den Boom & Sipman, 2014)
360	Gomphillaceae	*Asterothyrium pittieri*	Suriname	(van den Boom & Sipman, 2014)
361	Gomphillaceae	*Asterothyrium tetrasporum*	Suriname	(van den Boom & Sipman, 2014)
362	Gomphillaceae	*Asterothyrium uniseptatum*	Suriname	(van den Boom & Sipman, 2014)
363	Ramalinaceae	*Bacidina Aapiahica*	Suriname	(van den Boom & Sipman, 2014)
364	Ramalinaceae	*Bacidina hypophylla*	Suriname	(van den Boom & Sipman, 2014)
365	Ramalinaceae	*Bacidina neotropica*	Suriname	(van den Boom & Sipman, 2014)
366	Ramalinaceae	*Bacidina defecta*	Guyana	(van den Boom & Sipman, 2014)
367	Ramalinaceae	*Bacidina simplex*	Guyana	(van den Boom & Sipman, 2014)
368	Pilocarpaceae	*Brasilicia brasiliensis*	Suriname	(van den Boom & Sipman, 2014)
369	Pilocarpaceae	*Byssolecania hymenocarpa*	Guyana	(van den Boom & Sipman, 2014)
370	Pilocarpaceae	*Byssoloma humboldtianum*	Guyana	(van den Boom & Sipman, 2014)
371	Pilocarpaceae	*Byssoloma hypophyllum*	Guyana	(van den Boom & Sipman, 2014)
372	Pilocarpaceae	*Byssoloma aurantiacum*	Suriname	(van den Boom & Sipman, 2014)
373	Pilocarpaceae	*Byssoloma citricola*	Suriname	(van den Boom & Sipman, 2014)
374	Gomphillaceae	*Calenia dictyospora*	Suriname	(van den Boom & Sipman, 2014)
375	Gomphillaceae	*Calenia surinamensis*	Suriname	(van den Boom & Sipman, 2014)
376	Gomphillaceae	*Caleniopsis conspersa*	Suriname	(van den Boom & Sipman, 2014)
377	Pilocarpaceae	*Calopadia foliicola*	Suriname	(van den Boom & Sipman, 2014)
378	Pilocarpaceae	*Calopadia perpallida*	Suriname	(van den Boom & Sipman, 2014)

379	Graphidaceae	*Chroodiscus neotropicus*	Suriname	(van den Boom & Sipman, 2014)
380	Arthoniaceae	*Cryptothecia effusa*	Guyana	(van den Boom & Sipman, 2014)
381	Coenogoniaceae	*Coenogonium barbatum*	Suriname	(van den Boom & Sipman, 2014)
382	Coenogoniaceae	*Coenogonium ciliatum*	Suriname	(van den Boom & Sipman, 2014)
383	Coenogoniaceae	*Coenogonium dilucidum*	Suriname	(van den Boom & Sipman, 2014)
384	Coenogoniaceae	*Coenogonium hypophyllum*	Suriname	(van den Boom & Sipman, 2014)
385	Coenogoniaceae	*Coenogonium lisowskii*	Suriname	(van den Boom & Sipman, 2014)
386	Coenogoniaceae	*Coenogonium siquirrense*	Suriname	(van den Boom & Sipman, 2014)
387	Coenogoniaceae	*Coenogonium subluteum*	Suriname	(van den Boom & Sipman, 2014)
388	Gomphillaceae	*Echinoplaca handelii*	Suriname	(van den Boom & Sipman, 2014)
389	Roccellaceae	*Enterographa paruimae*	Guyana	(van den Boom & Sipman, 2014)
390	Ramalinaceae	*Eschatogonia dissecta*	Guyana	(van den Boom & Sipman, 2014)
391	Pilocarpaceae	*Fellhanera punctata*	Guyana	(van den Boom & Sipman, 2014)
392	Pilocarpaceae	*Fellhanera ruida*	Guyana	(van den Boom & Sipman, 2014)
393	Pilocarpaceae	*Fellhanera flavostanhopeae*	Suriname	(van den Boom & Sipman, 2014)
394	Pilocarpaceae	*Fellhanera rhaphidophylli*	Suriname	(van den Boom & Sipman, 2014)
395	Gomphillaceae	*Gyalideopsis lobulata*	Suriname	(van den Boom & Sipman, 2014)
396	Graphidaceae	*Graphis furcata*	Guyana	(van den Boom & Sipman, 2014)
397	Pilocarpaceae	*Loflammia epiphylla*	Guyana	(van den Boom & Sipman, 2014)
398	Lyrommataceae	*Lyromma confusum*	Guyana	(van den Boom & Sipman, 2014)
399	Lyrommataceae	*Lyromma dolicobelum*	Guyana	(van den Boom & Sipman, 2014)
400	Lyrommataceae	*Lyromma ornatum*	Suriname	(van den Boom & Sipman, 2014)
401	Roccellaceae	*Mazosia conica*	Guyana	(van den Boom & Sipman, 2014)
402	Roccellaceae	*Mazosia uniseptata*	Guyana	(van den Boom & Sipman, 2014)

403	Malmideaceae	*Malmidea gyalectoides*	Guyana	(van den Boom & Sipman, 2014)
404	Phyllobatheliaceae	*Phyllobathelium anomalum*	Suriname	(van den Boom & Sipman, 2014)
405	Phyllobatheliaceae	*Phyllobathelium firmum*	Suriname	(van den Boom & Sipman, 2014)
406	Trichotheliaceae	*Porina Moralesiae*	Guyana	(van den Boom & Sipman, 2014)
407	Trichotheliaceae	*Porina rubescens*	Guyana	(van den Boom & Sipman, 2014)
408	Trichotheliaceae	*Porina tetracerae*	Guyana	(van den Boom & Sipman, 2014)
409	Strigulaceae	*Strigula transversoundulata*	Guyana	(van den Boom & Sipman, 2014)
410	Strigulaceae	*Strigula nigrocarpa*	Guyana	(van den Boom & Sipman, 2014)
411	Strigulaceae	*Strigula orbicularis*	Suriname	(van den Boom & Sipman, 2014)
412	Strigulaceae	*Strigula subelegans*	Suriname	(van den Boom & Sipman, 2014)
413	Pilocarpaceae	*Tapellaria nigrata*	Guyana	(van den Boom & Sipman, 2014)
414	Pilocarpaceae	*Tapellaria major*	Suriname	(van den Boom & Sipman, 2014)
415	Pilocarpaceae	*Tapellariopsis octomera*	Guyana, Suriname	(van den Boom & Sipman, 2014)
416	Gomphillaceae	*Tricharia longispora*	Guyana	(van den Boom & Sipman, 2014)
417	Trichotheliaceae	*Trichothelium pallidisetum*	Guyana, Suriname	(van den Boom & Sipman, 2014)
418	Trichotheliaceae	*Trichothelium minus*	Suriname	(van den Boom & Sipman, 2014)
419	Epibryaceae	*Epibryon lichenicola*	Guyana	(van den Boom & Sipman, 2014)
420	Gyalectaceae	*Keratosphaera dimerella*	Suriname	(van den Boom & Sipman, 2014)
421	Opegraphaceae	*Opegrapha phylloporinae*	Suriname	(van den Boom & Sipman, 2014)
422	Leptosphaeriaceae	*Leptosphaeria corae*	Brazil	(Vanino, 1890)
423	Stereocaulaceae	*Lepraria leuckertiana*	Chile	(Zedda 2000), (Flakus et al. 2006), (Saag et al. 2009)
424	Stictidaceae	*Cryptodiscus gassicurtiae*	Brazil	Etayo et al., 2020)
425	Caliciaceae	*Gassicurtia coccinea*	Brazil	Etayo et al., 2020)

426	Mycosphaerellaceae	*Stigmidium anguinellicola*	Brazil	Etayo et al., 2020)
427	Opegraphaceae	*Nyungwea anguinella*	Brazil	Etayo et al., 2020)

According to Table 5 (as shown above), fifty-eight (58) lichen families were represented with a grand total of four hundred twenty-seven lichens (427) species of lichens from twelve (12) neotropical countries, mainly: Guyana, Suriname, Brazil, Bolivia, Peru, Argentina, Columbia, Chile, Ecuador, Venezuela, Costa Rica and Madagascar. Upon further analysis, the results revealed that seventy-two (72) species of lichens were commonly found in both Guyana and Suriname and twelve (12) species of lichens were found in both Guyana and Brazil. In addition, eight (8) species of lichens were common among Bolivia and Peru, six (6) among Bolivia and Chile, five (5) among Bolivia and Columbia, four (4) among Bolivia and Brazil and Bolivia and Ecuador respectively, two (2) among Bolivia and Argentina as well as Bolivia and Venezuela and one (1) among Brazil and Venezuela.

4.3. Factors that affect the distribution of lichens in the neotropics

The distribution of lichens, functional trait assemblages should be examined not only at the level of differences in the internal structure of the analyzed forest communities (e.g., a greater number of diverse substrates or tree species), but also in relation to specific habitat conditions (insolation, moisture, temperature, eutrophication) that are unique to each forest community [39], [76]. In 2009, a study was conducted on the floodplain forest by Jüriado *et al*. and they observed that lichen distribution depended upon a host of factors including tree species, bark acidity, light availability, latitude, tree age, and trunk circumference.

The sensitivity of lichens to air quality is well known. They are affected by the climate as well as other variables that affect forests [136]. Primary climate variables such as precipitation and temperature, as well as geographical gradients such as elevation and latitude that integrate climate elements, affect forest lichen populations [11], [22], [87], [134], [135]. Temperature and precipitation patterns can have a big impact on lichen-forming fungi dispersion [58]. Some places, particularly in the Northern Coastal Ranges, do not receive nearly as much rainfall as others, but they do get a lot of coastal fog, which is important for lichen populations since they absorb water and water vapor through their cortex [98].

Because both air pollution and climate change have the potential to impair long-term sustainability and biodiversity, lichen response indices for these factors can help researchers better understand the causes of lichen biodiversity patterns and trends [136]. Climate interacts with other elements to potentially contribute to forest and lichen vulnerability to disease, damage, invasion by exotics, or changes in biodiversity, as opposed to forest health variables such as those listed above [136].

Epiphytic lichens have a narrow pH tolerance controlling colonization of bark surfaces [54], [97], [106], [132]. *Flavoparmelia caperata* commonly called the green shield lichen are abundantly found on oak and holly, are well adapted to acidic environments [67]. Subsequently, limiting factors, such as site conditions, pollution, light intensity and life expectancy of species are all factors that can affect the distribution of lichens [9]. External stress such as drought have also been shown to affect the distribution of lichen and their ability to reduce the effect of suppressing seed germination [49].

Anthropogenic activities (human disturbances) also negatively impact the distribution of lichens. A study that was conducted by Niemi & McDonald in 2004 and another that was executed by Catalano *et al*. in 2013 revealed that *Seirophora villosa*, a rare species, may become extinct as a result of human disruptions (*S. villosa* can also be found in the neotropics, especially South American countries such as Argentina, Chile, and Peru). A drop in the lichen population can also be caused by the presence of buildings near habitat places, vehicle-emission, air-pollution, nitrogen deposition, and aridity/ humidity caused by sea wind. Other environmental elements, such as the legacy of old-growth conditions in forests, can be inferred from the presence, or absence, of species [108]. Other factors such as bioclimatic, topographic, stand, and parent rock variables influence the lichen species composition and distribution [109].

5. Conclusion

This review emphasized on the diversity of lichens and what factors affect their distribution in the neotropics. Despite lichens have many importance and benefits such as: food, cosmetology, pharmaceutical and therapeutic potentials, pioneer and keystone species, biomonitoring etc.; lichen diversity is vast in the neotropics and many abiotic factors can influence their distribution. Abiotic factors such as temperature, pH, humidity, moisture, latitude, topography, light availability and anthropogenic activities by human beings e.g., pollution and deforestation play a heavy influence on lichens and their distribution in the neotropics as well as globally. More research should be done when it comes to lichen diversity and factors affecting their distribution, especially in Guyana. Many of the papers that were reviewed focused on lichen diversity and factors that affect their distribution outside the neotropical realm and few focused on lichen diversity and distribution in neotropical countries, hence, more research should be done since a limited amount of research was done on lichens in the Neotropics.

Compliance with ethical standards

Acknowledgments

The authors would like to thank the University of Guyana, Division of Natural Sciences, Department of Biology for giving this tremendous opportunity and supporting the successful completion of this research. The author would like to express his sincerest gratitude to the following individuals who have assisted and provided supervisory insights throughout this research: Mr. Rahaman Balkarran, Mr. Phillip Da Silva, Dr. Gyanpriya Maharaj, Prof. Gomathinayagam Subramanian, Ms. Ferial Pestano, Ms. Chalasa Cossiah and Ms. Sushmita Kalika-Singh.

Disclosure of conflict of interest

The authors hereby declare that this manuscript does not have any conflict of interest.

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