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# Preliminary inventory of corticolous lichens of the Sierra de San Luis, Venezuela

# Inventario preliminar de líquenes cortícolas de la Sierra de San Luis, Venezuela

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## Abstract

**Objective:** In order to survey the composition of lichen flora in the northern slopes of Sierra de San Luis, Venezuela, six localities along an altitudinal gradient (0-1,400 elevation) were sampled. **Methods:** Lichens were collected in 60 trees from ground level to 1.3 m high on tree trunks. **Results:** A total of 85 species, distributed in 40 genera and 25 families were identified, representing 6.3% of the total lichen richness of Venezuela. Families Graphidaceae, Physciaceae and Porinaceae are the most diverse with 18, nine and seven species, respectively. Seventy percent of the total species have a crustose thallus. This study provides the first inventory of lichens for the region, contributing with range extensions for 46 species reported as new for Venezuela

**Keyword**: Altitudinal gradient, Checklist, Lara-Falcon Hill System, Northern South America,

## Resumen

**Objetivo:** Con el objeto de inventariar la composición de la flora de líquenes cortícolas en la vertiente norte de la Sierra de San Luis en Venezuela, fueron muestreadas seis localidades con diferentes tipos de vegetación a lo largo de un gradiente altitudinal (0-1,400 metros de elevación). **Métodos:** Los líquenes fueron colectados en 60 árboles, desde el nivel del suelo hasta 1.3 m. de altura sobre los troncos de los árboles. **Resultados:** Se identificaron un total de 85 especies distribuidas en 40 géneros y 25 familias, que representan 6.3% del total de la riqueza de líquenes de Venezuela. Las familias Graphidaceae, Porinaceae y Pyrenulaceae fueron las más diversas con 18, siete y seis especies, respectivamente. Poseen talo crustáceo 70% del total de las especies registradas. Este trabajo proporciona el primer inventario de líquenes en la Sierra de San Luis, contribuyendo con nuevos registros de distribución para 46 especies reportadas por primera vez para Venezuela.

**Palabras clave**: Gradiente altitudinal, Lista, Norte de Suramérica, Sistema de Colinas Lara-Falcón.

## Introduction

Lichens play an important role in the vegetal communities where they inhabit. They are pioneers in the colonization of soils and bare rocks and support the water and nutrient retention in the forests (Purvis 2000) Lichens are used for different purposes by many organisms; just for instance, insects use lichens for mimetism, and some vertebrates include them in their diet, like humans and *Umbilicaria* sp. (Moreno *et al*. 2007).

On the other hand, in the last decades, lichens have been used as bioindicators of air pollution because of their particular biological characteristics, among them, a slow growth thallus, lack of cuticle and the precise ecological requirements. The lichenous symbiosis is an example of a successful evolutionary strategy, that has produced at least 20,000 species worldwide (Feuerer and Hawksworth 2006), which has allowed these organisms to inhabit almost all existing environment.

Although Feuerer (2012) and Marcano (2003)

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estimated the number of lichen species for Venezuela around 1,350 species distributed in 181 genera and 49 families, there is not a total official number of lichens species for the country. Inventory efforts have been done in only four of the 13 bioregions of the country. Lichens inventories within the country have been scarce, with only eight specific reports on lichens in the pertinent literature (Arias 2011; Komposch and Hafellner 2000; López-Figueiras 1986; López-Figueiras and Morales 1989a, b; Lücking *et al.* 2012; Mata-García and Lampe 1994; Mata-García 1995). The current lack of information about lichens in Venezuela may be related to the limited resources invested to study these organisms. The aim of this study was to provide a comprehensive lichen inventory of the Sierra de San Luis in Venezuela in order to extend the information of the biodiversity in this area.

## Methodology

***Study area***. The Sierra de San Luis is a mountain system located in the state of Falcon (Figure 1), specifically in the bioregion denominated the Lara-Falcón Hill System. Its extension is about 37 km long and five to seven km wide. The Sierra de San Luis is separated from the mountain range of the Andes and the central and eastern costal range, therefore it is considered an island surrounded by valleys and dry deserts (Steyermark 1975); it extends from latitudes 11°08'30" North to 11°20'00" North and 69°27'00" West to 69°42'25" West, and from sea level to 1,500 elevation in general, the Sierra de San Luis is under the influence of a wet and hot tropical climate with a mean annual temperature of 18°C to 27°C. In the mountains the rainy season starts in October and ends in January, while in the valleys it lasts from May to July; the mean annual rainfall is 700 to 1,000 mm (Hijmans *et al.* 2005).

***Methods***

***Data collection and analysis***. Field work was executed between June and July 2010 in the northern slope of the Sierra de San Luis. Specimens were collected in six sites along an altitudinal gradient from 100 to 1,400 elevation: La Quebrada (11º 17' 49" North, 69º 36' 49" West, 106 elevation); La Subida (11º17'08''North, 69º36'27'' West, 275 elevation); La Curva (11º16'36''North, 69º36'12'' West, 430 elevation); La Chapa (11°15'41" North, 69°36'21"

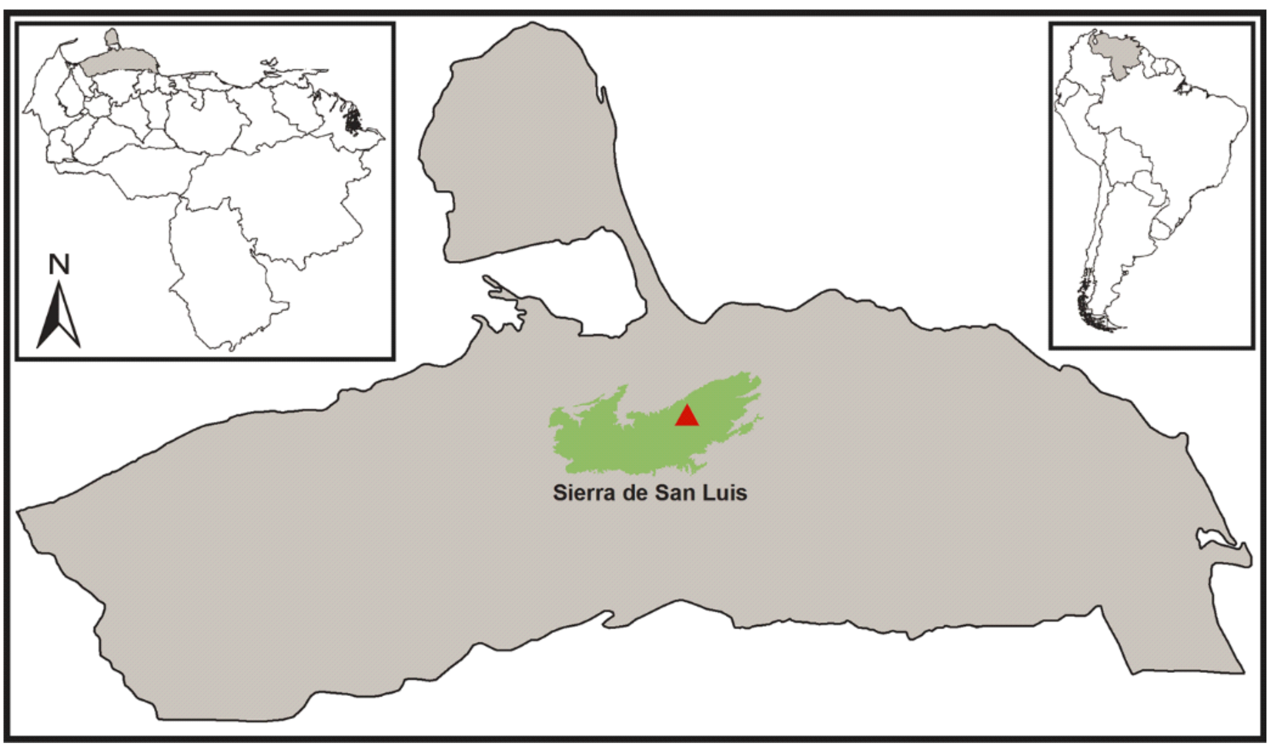


**Figure 1.** Geographic location of the study. Green polygon delimits the Sierra de San Luis. Red triangle indicates collection sites.

West, 739 elevation); La Ciénega (11º14'47'' North, 69º36'53'' West, 978 elevation); El Chorro (11º13'31'' North, 69º36'58'' West, 1.400 elevation).

Lichens were collected from 60 trees (10 trees per collection point), from ground level to 1.3 m high on tree trunks. Each sample was separated from the substrate using a knife and hammer. Samples were air dried for 24 hours. Data on growth form, macroscopic thallus morphology and the presence of reproductive structure were recorded.

Sample identification was performed in the National Herbarium of Venezuela (VEN). Lichens were identified by studying the morphology, anatomy and chemistry of the specimens. This process began with macroscopic observations of the collected material using a stereomicroscope (Leica MS5), as well as the examination of sexual and asexual reproductive structures, presence and color of hypothallo, cilium, medulla and cortex. Lichens reproductive structures were dissected in order to recognize number, form and size of spores, and segments of lumen. Four chemical test colors were used as part of the identification process (Chaparro and Aguirre 2002; Moreno *et al*. 2007): sodium hypochlorite (NaOCL), potassium iodide (KI), potassium hydroxide (KOH), and paraphenyldiamine (PD). The fluorescence test was done with an UV lamp with 366 nm wave length.

Specimen identification followed Lücking *et al.* (2001), Nash *et al.* (2002) and Sipman and Aptroot (2005), and Cáceres (2007). Finally, the nomenclature was standardized following the Index Fungorum (CABI and Landcare Research 2012). Voucher specimens were deposited at the herbarium of the Museo de Biologia, Facultad Experimental de Ciencias, Universidad del Zulia, Maracaibo, Venezuela (MBLUZ).

Potential number of species along the gradient was estimated with EstimateS 8.2 (Colwell 2009) using the Chao2 richness estimator as suggested by Chao (1987). Species accumulation curve was adjusted with Clench function (Jimenez-Valderde and Hortal 2003) using Statistica 8.0 (StatSoft 2007).

## Results

A total of 85 species belonging to 40 genera and 25 families were recorded in the Sierra de San Luis (Table 1). The identification of 16 taxa was uncertain, (marked as sp.). Fourty-six lichen species, represent new records for Venezuela (Table 2, Figure 2).

Four families contributed with 47% of total number of species, families with greater number of species were Graphidaceae (18 spp.), Physciaceae (9 spp.), Porinaceae (7 spp.) and Pyrenulaceae (6 spp.). The predominant thallus type in the gradient was crustose, with 61 species which represents 70% of the total species. In less proportion, 17 species had a foliose thallus, seven species had a squamulose thallus and four species had a gelatinous thallus.

The species accumulation curve, produced in this work, did not reach the asymptote ($y=(202.3073x)/(1+0.359567x)$); the number of species estimated through the Chao2 was 562, indicating an approximate underestimation of 477 species.

## Discussion

The species richness found in this study represents 6.3% of the lichen richness reported for Venezuela (1345 spp., Feuerer 2012). Based on previously reported geographic distributions we concluded 46 species documented in this work, constitute new records for Venezuela (based on Feuerer 2012, GBIF 2012), and they are described in Table 2.

It is important to mention that the lichen flora of Sierra de San Luis had not been studied before, and the lack of the asymptote in conjunction with the high underestimation of true richness in Chao2 indicates that we are still far from describing the actual richness of corticolous lichens of the Sierra de San Luis.

Marcano (2003) conducted an inventory in the northeast coast of Venezuela reporting 51 species; Kelly *et al*. (2004) found 46 species in 20 trees in the Mountain Range of Mérida. Recently, two new country records and 10 new states records were reported in Mountain Range of Perijá (Arias 2011); Lücking *et al*. (2012) described three new species of Graphidaceae from the Central Coastal Range. The results from this study cannot be contrasted with others lichen inventories because the inconsistency of survey methods and environmental conditions among study sites.

The families Graphidaceae and Physciaceae are considered as abundant in the Neotropics, with a large number of genera unlike Porinaceae and Pyrenulaceae (Rincon *et al*. 2011). Although the families Porinaceae

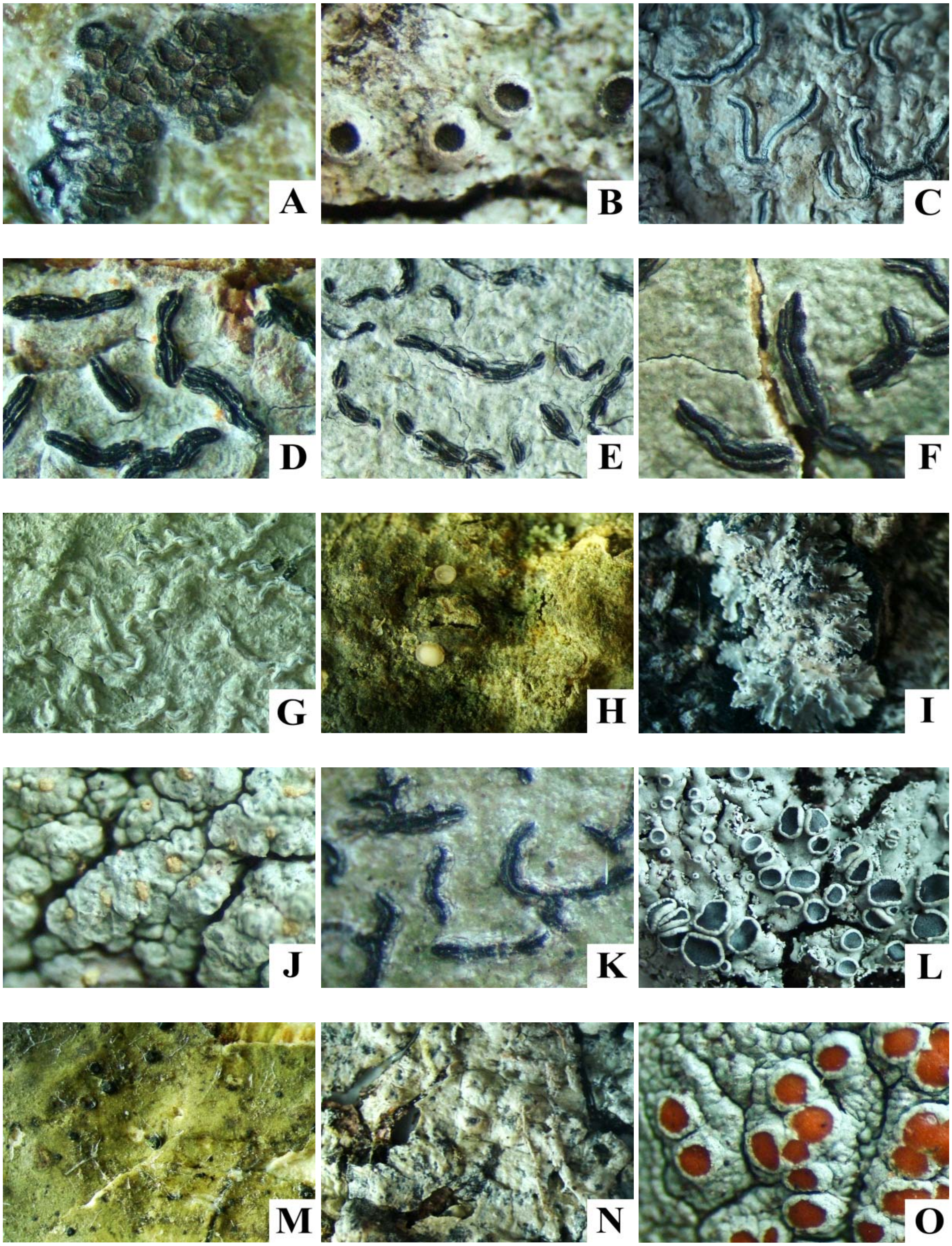


**Figure 2.** New records of corticolous lichens for Venezuela. (A) *Glyphis cicatricosa*, (B) *Glyphis scyfulifera*, (C) *Graphis acharii*, (D) *Graphis dupaxana*, (E) *Graphis leptoclada*, (F) *Graphis striatula*, (G) *Graphis timidula*, (H) *Malmidea gyalectoides*, (I) *Parmeliella stylophora*, (J) *Pertusaria flavens*,(K) *Phaeographis asteroides*, (L) *Physcia undulata*, (M) *Porina atrocoerulea*, (N) *Porina mastoidea,* (O) *Haematomma persoonii*. Photos by Gabriela Lugo-Fuenmayor.

**Table 1.** List of corticolous lichens recorded from the study area

| **Taxa** |
|---|
| **Arthoniomycetes** |
| **Arthoniaceae** |
| **Arthoniaceae** |
| *Arthonia aff. complanata* |
| *Herpothallon mycelioides* |
| *Herpothallon rubrocinctum* |
| **Roccellaceae** |
| *Opegrapha aperiens* |
| *Opegrapha cf. robusta* |
| *Opegrapha quintana* |
| **Eurotiomycetes** |
| **Pyrenulales** |
| **Pyrenulaceae** |
| *Pyrenula concatervans* |
| *Pyrenula cuyabensis* |
| *Pyrenula macrocarpa* |
| *Pyrenula microcarpa* |
| *Pyrenula nitidula* |
| *Pyrenula tenuisepta* |
| **Insertae sedis** |
| **Byssolomataceae** |
| *Byssoloma subdiscordans* |
| **Lecanoromycetes** |
| **Candelariales** |
| **Candelariaceae** |
| *Candelaria concolor* |
| **Lecanoromycetes** |
| **Lecanolares** |
| **Cladoniaceae** |
| *Cladonia subsquamosa* |
| **Ectolechiaceae** |
| *Calopadia turbinata* |
| **Haematommataceae** |
| *Haematomma aff. infuscum* |
| *Haematomma persoonii* |
| **Lecanoraceae** |
| *Lecanora achroa* |
| *Lecanora casuarinophila* |
| *Lecanora cf. tropica* |
| *Lecanora sp.* |
| *Lecanora tropica* |
| **Malmideaceae** |
| *Malmidea gyalectoides* |
| **Ramalinaceae** |
| *Bacidia* sp. |
| **Lecanoromycetes** |
| **Ostropales** |
| **Gomphillaceae** |
| *Aderkomyces* sp. |
| *Aulaxina* sp. |
| *Gyalideopsis capitata* |
| *Gyalideopsis lambinonii* |
| *Gyalideopsis* sp. |
| **Graphidaceae** |
| *Fissurina incrustans* |
| *Fissurina instabilis* |
| *Glyphis cicatricosa* |
| *Glyphis scyphulifera* |
| *Graphis acharii* |
| *Graphis* sp. |
| *Graphis consimilis* |
| *Graphis disserpens* |
| *Graphis dupaxana* |
| *Graphis hyphosa* |
| *Graphis leptoclada* |
| *Graphis oligospora* |
| *Graphis pavoniana* |
| *Graphis pinicola* |
| *Graphis scripta* |
| *Graphis striatula* |
| *Graphis timidula* |
| *Phaeographis asteroides* |
| **Porinaceae** |
| *Porina atrocoerulea* |
| *Porina guaranitica* |
| *Porina mastoidea* |
| *Porina nucula* |
| *Porina* sp. |
| *Porina tetracerae* |
| *Porina tetralocularis* |
| **Thelotremataceae** |
| *Chapsa dilatata* |
| *Ocellularia bahiana* |
| *Ocellularia* sp.1 |
| *Ocellularia* sp.2 |
| **Lecanoromycetes** |
| **Peltigerales** |
| **Coccocarpiaceae** |
| *Coccocarpia palmicola* |
| **Coenogoniaceae** |
| *Coenogonium confervoides* |
| *Dimerella* sp. |
| **Collemataceae** |
| *Leptogium austroamericanum* |
| *Leptogium marginellum* |
| *Leptogium reticulatum* |
| **Lobariaceae** |
| *Pseudocyphellaria aurata* |
| *Sticta* sp. |
| **Pannariaceae** |
| *Parmeliella stylophora* |
| **Lecanoromycetes** |
| **Pertusariales** |
| **Pertusariaceae** |
| *Pertusaria dehiscens* |
| *Pertusaria flavens* |
| *Pertusaria* sp.(caceres) |
| *Pertusaria tetrathalamia* |

**Table 1.** List of corticolous lichens recorded from the study area

| Taxa | |
|---|---|
| **Lecanoromycetes** | *Hyperphyscia adglutinata* |
| **Teloschistales** | *Hypotrachina divaricatica* |
| **Caliciaceae** | *Physcia krogiae* |
| *Amandinea* sp. | *Physcia pachyphylla* |
| *Buellia* sp. | *Physcia undulata* |
| *Pyxine simulans* | *Rinodina* sp. |
| **Physciaceae** | **Lichinomycetes** |
| *Heterodermia boryi* | **Lichinales** |
| *Heterodermia circinalis* | **Peltulaceae** |
| *Heterodermia japonica* | *Peltula* sp. |

**Table 2.** New records of corticolous lichens species in Venezuela

| Taxa | Worldwide distribution (*based on* Feuerer 2012, GBIF 2012) |
|---|---|
| *Calopadia turbinata* | Costa Rica, Nicaragua. |
| *Coenogonium confervoides* | Costa Rica, Gudeloupe, Reunion. |
| *Glyphis cicatricosa* | Argentina, Christmas Island, Bahamas, Bolivia, Brazil, China, Cook Island, Costa Rica, Ecuador, Fiji, Guadeloupe, New Caledonia, Reunion, French Guiana, Guyana, India, Indonesia, Oceania, Papua New Guinea, Portugal, Samoa, Seychelles, South Africa, Spain, St. Lucia, Taiwan, Thailand, Bermuda, Uruguay, USA: mainland and Hawaii, Vanuatu. |
| *Glyphis scyphulifera* | Argentina, Australia, Brazil, China, Costa Rica, Guyana, Hong Kong, Laos, Malaysia, Myanmar, Nicaragua, Papua New Guinea, Paraguay, Philippines, Puerto Rico, Singapore, South Africa, USA. |
| *Graphis acharii* | Ecuador. |
| *Graphis consimilis* | Colombia, Papua New Guinea. |
| *Graphis dupaxana* | China, Japan, Taiwan. |
| *Graphis hyphosa* | Costa Rica. |
| *Graphis leptoclada* | Honduras, Australia. |
| *Graphis oligospora* | China. |
| *Graphis pavoniana* | Argentina, Brazil, Comoros, Oceania, Bermuda, Uruguay, USA. |
| *Graphis pinicola* | China. |
| *Graphis striatula* | Argentina, Brazil, China, Costa Rica, Guadeloupe, New Caledonia, India, Oceania, South Africa, Thailand, Bermuda, Uruguay, USA: mainland and Hawaii. |
| *Graphis timidula* | Sao Tome & Principe. |
| *Gyalideopsis capitata* | Costa Rica. |
| *Gyalideopsis lambinonii* | Brazil, Costa Rica, Taiwan. |
| *Haematomma aff. infuscum* | Australia. |
| *Haematomma persoonii* | Brazil, China, Costa Rica, New Caledonia, Mozambique, Oceania, South Africa, Taiwan, USA. |
| *Herpothallon mycelioides* | Australia, Fiji. |
| *Heterodermia circinalis* | Colombia, Costa Rica, Ecuador, St. Elena. |
| *Hyperphyscia adglutinata* | Albania, Algeria, Argentina, Armenia, Tasmania, Austria, Bhutan, Brazil, Chile, China, Costa Rica, Croatia, Czechia, Estonia, France, New Caledonia, French Guiana, Germany, Guyana, Ireland, Israel, Italy, Mongolia, Montenegro, Morocco, Netherlands, New Zealand, Norway, Oceania, Papua New Guinea, Poland, Portugal, Romania, Saudi Arabia, Spain, Suriname, Sweden, Taiwan, Tunisia, USA: mainland and Hawaii. |
| *Hypotrachina divaricatica* | Brazil. |
| *Lecanora achroa* | Argentina, Brazil, Costa Rica, Taiwan, British Indian Ocean Territory. |
| *Lecanora casuarinophila* | Brazil. |

**Table 2.** New records of corticolous lichens species in Venezuela

| Taxa | Worldwide distribution (*based on* Feuerer 2012, GBIF 2012) |
|---|---|
| *Lecanora tropica* | Argentina, Australia, Bolivia, Costa Rica, New Caledonia, India, Oceania, Papua New Guinea, Seychelles, St Lucia, Taiwan, British Indian Ocean Territory, St Elena. |
| *Malmidea gyalectoides* | Paraguay. |
| *Opegrapha aperiens* | Brazil. |
| *Opegrapha cf. robusta* | Papua New Guinea, Thailand. |
| *Opegrapha quintana* | Brazil. |
| *Parmeliella stylophora* | Costa Rica. |
| *Pertusaria dehiscens* | Brazil, India, Oceania, Papua New Guinea. |
| *Pertusaria flavens* | Argentina, Brazil, Guadeloupe, South Africa, Yemen. |
| *Phaeographis asteroides* | Netherlands Antilles, USA. |
| *Physcia krogiae* | Costa Rica, Guyana, Papua New Guinea, Suriname, British Indian Ocean Territory. |
| *Physcia pachyphylla* | Argentina, Costa Rica, Uruguay. |
| *Physcia undulata* | Argentina, Christmas Island, Bolivia, Brazil, Chile, Costa Rica, Spain, USA. |
| *Porina atrocoerulea* | Argentina, Brazil, Bolivia, Costa Rica, French Guiana, Guyana, New Zealand, Paraguay, Suriname, Vietnam. |
| *Porina guaranitica* | Brazil, Paraguay, Portugal, Spain. |
| *Porina mastoidea* | Argentina, Bahamas, Bolivia, Brazil, Costa Rica, New Caledonia, French Guiana, Guyana, India, Oceania, Panama, Papua New Guinea, Paraguay, Portugal, Suriname, Taiwan, Thailand, Uruguay, USA. |
| *Porina tetralocularis* | Guyana. |
| *Pyrenula concatervans* | Australia, Costa Rica, India, Micronesia, Oceania, Papua New Guinea, Seychelles, Taiwan, United Kingdom, USA: mainland and Hawaii. |
| *Pyrenula cuyabensis* | USA. |
| *Pyrenula macrocarpa* | Papua New Guinea, Thailand, USA. |
| *Pyrenula microcarpa* | Micronesia, Oceania, Papua New Guinea, USA. |
| *Pyrenula nitidula* | China, Costa Rica, French Guiana, Papua New Guinea, Taiwan, United Kingdom. |
| *Pyxine simulans* | Brazil. |

and Pyrenulaceae have a few genera, in this study they were the third and fourth families, respectively, with greater species richness. Although the families Porinaceae and Pyrenulaceae have a few genera, in this study they were the most diverse. This could be related with the type of photobiont that they have (green algae). It is well known the important role played by the photobiont in the competitive interaction between different genera of lichens (Hawksworth 1988). Green algae are abundant and highly diverse in tropical forest, favoring the adaptation to dominate habitats with particular conditions such as high rainfall and low light intensity (Lakatos *et al*. 2006). Wolseley and Hawksworth (2009) explained the interaction of the photosynthetic partners of lichens; the Graphidaceae family has the algae Trentepohlia as photobiont, which is widely distributed in tropical and sub-tropical forest from tree branches and bark to wet rocks, this readily availability of Trentepohlia allow to groups as Graphidaceae be more abundant and diverse. The high representation of this family in the Sierra de San Luis could be related to their photobiont.

Finally, the dominance of crustose thalli is similar to other forest areas in the Neotropics (Brodekova *et al*. 2006; Hawksworth *et al*. 2005; Lakatos *et al*. 2006; Pinokiyo *et al*. 2008). The high percentage of crustose thallus could be related to the adaptations developed by the lichens to inhabit tropical rainforests, which exhibit high and low levels of humidity and light, respectively. The efficiency to exploit the low light levels is based to accomplish the photosynthesis in the thallus (Wolseley and Hawksworth 2009).

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