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# Alpha diversity of lichens associated with *Quercus laurina* in a mountain cloud forest at Cofre de Perote eastern slope (La Cortadura), Veracruz, Mexico

*Octavio CÓRDOVA-CHÁVEZ[a], Gonzalo CASTILLO-CAMPOS[a], Rosa Emilia PÉREZ-PÉREZ[b*], José Guadalupe GARCÍA-FRANCO[a] & Marcela Eugenia da Silva CÁCERES[c]*

[a] *Instituto de Ecología, A.C. Carretera Antigua a Coatepec, No. 351, El Haya, CP 91070 Xalapa, Veracruz, México*

[b] *Escuela de Biología, Benemérita Universidad Autónoma de Puebla CP 72570, Puebla, México*

[c] *Departamento de Biociências, Universidade Federal de Sergipe, CEP: 49500-000, Itabaiana, Sergipe, Brazil*

***Abstract*** – An inventory of epiphyte lichens was carried out on 15 phorophytes of *Quercus laurina* Humb. & Bonpl. located along a mountain ridge in a mountain cloud forest at La Cortadura Ecological Reserve, Coatepec, Veracruz. For each tree the five zones following Johansson's method were distinguished. Ascents were made in selected trees using the single-rope technique, collecting samples along the trunk and some branches of the crown. A total of 126 lichen species were found, belonging to 60 genera, 24 families and 10 orders. The most diverse genus was *Graphis* (12 species), followed by *Parmotrema* (9), *Hypotrachyna* (8), *Pertusaria* and *Usnea* (5). Crustose lichens dominated (79%) over foliose (38%) and fruticose (8%) types. Although some species preferred one of the trees while others were common to all (13), no significant differences were observed between phorophytes. The genus *Sticta* was found in basal and intermediate tree zones; *Ramalina* and *Usnea* were recorded in all areas. Twenty-one new records are reported for Mexico, and 21 for the state of Veracruz.

**Inventory / Oak forest / Vertical distribution / Richness /**

## INTRODUCTION

In Mexico, the mountain cloud forest (MCF) covers a mere 0.8% of the total area (Williams-Linera, 2012). In spite of this, MCF is the ecosystem with the highest plant and animal diversity per square meter (Challenger & Soberón, 2008), with some 2,500 species of plants, equivalent to 10%-12% of the country's total plant biodiversity, of which vascular epiphytes (Bromeliaceae and Orchidaceae) show the greatest diversity and endemism (Rzedowski, 2006; Williams-Linera,

* Corresponding Author: emilia.perez@correo.buap.mx

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2012; Gual-Díaz & Rendón-Correa, 2014). However, some groups of plants, animals and fungi remain little known, as is the case of lichens.

To date, 2,833 lichen taxa have been recorded in Mexico; given the diversity of vegetation types and climatic zones in the country, this translates into an estimated total of about 5,000 species (Lücking *et al*., 2009; Herrera-Campos *et al*., 2014). Previus studies on MCF have recorded 230 species of lichens (Herrera-Campos *et al.,* 2014). This figure is low, considering that Neotropical mountain forests usually thrive in areas where humid air coming from the sea condensates, forming dense cloud masses that concentrate moisture and bring about heavy rainfall (Gual-Díaz & Rendón-Correa, 2014), conditions which favor the establishment and presence of lichens, especially corticolous ones (Sipman, 2006). Besides, the genus *Quercus* usually predominates in these ecosystems, being one of the tree genera showing the greatest diversity of lichens (Tore & Ozturk, 2009).

Veracruz is one of states in Mexico that is better inventoried, with 700 lichen species recorded (Herrera-Campos *et al.,* 2014). However, in Veracruz most of these studies have been conducted in tropical forests in the region of Los Tuxtlas (Herrera-Campos & Lücking, 2002; Herrera-Campos *et al*., 2004; Bárcenas-Peña *et al*., 2014, 2015). Also, in recent years, studies have also focused on the cloud forest, from where three new species have been described and a total of 108 species for this type of forest have been reported (Córdova-Chávez *et al*., 2014; Pérez-Pérez *et al*., 2015). In spite of these numbers, the lichen flora of Veracruz is still little studied. On the other hand, works on corticolous lichens carried out in the country have focused on collecting specimens from ground level to the first 2 m of phorophyte height (Gómez-Peralta, 1992; Zambrano *et al*., 2000; Pérez-Pérez *et al*., 2011). Studies on the diversity of lichens growing higher up on tree trunks and crowns are extremely scarce, despite the importance of tree height for the diversity of lichens (McCune *et al*., 2000; Ellyson & Sillett, 2003; Normann *et al*., 2010). The present work is one of the first studies addressing corticolous lichens along the trunks of *Quercus laurina* Humb. & Bonpl., one of the tree species displaying the most diverse lichen flora in mountain cloud forests (Pérez-Pérez *et al*., 2015). The aim of this study was to document the species richness of corticolous lichens and to analyze whether there are differences on lichen species richness between phorophytes and between the five Johansson's zones.

## MATERIALS AND METHODS

*Study site:* The study was conducted at *La Cortadura* Ecological Reserve located on the eastern foothills of *Cofre de Perote*, a mountain range in the center of the state of Veracruz, Mexico (19° 29' 17.6" N and 97° 02' 25.9" E, at 2,000 m asl; Fig. 1). The climate is temperate and humid, with a mean annual temperature of 18 ºC and a mean annual precipitation of 2,500 mm (García-Franco *et al*., 2008; De La Rosa & Negrete-Yankelevich, 2012). The site comprises 107 ha, with nearly 45 ha covered by a relatively well-preserved MCF (De La Rosa & Negrete-Yankelevich, 2012). Since the local topography is very irregular (Fig. 1), the work was conducted on the top of a hill with steep slopes covered by mountain cloud forest. The sampling units were individual trees of *Quercus laurina*, one of the dominant species in MCF in the study area (Pérez-Pérez *et al*., 2015). *Q. laurina* reaches a mean height of 25 m and a DBH of 0.9 m (Hernández-Vital *et al*., 2009).

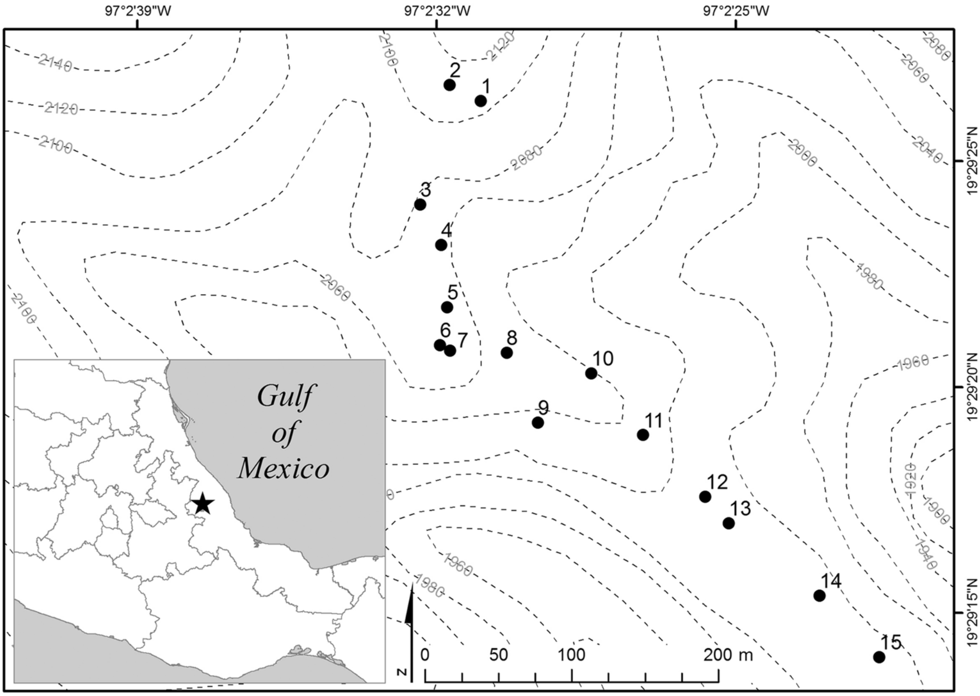


Fig. 1. Location of the sampling site in *La Cortadura* forest, Veracruz, Mexico. Dots and numbers in the map correspond to the sampled *Quercus laurina* phorophytes.

*Lichen sampling and taxonomic identification :* The sampling was carried out in 15 plots of 100 m$^2$ previously delineated along the hill top, separated from each other by approximately 25 m (Pérez-Pérez *et al*., 2015). Within each plot, one specimen of *Quercus laurina* with a diameter at breast height (DBH) greater than 40 cm was selected.

Tree climbing was performed using the single-rope ascent technique (Barker & Sutton, 1997; Barker & Pinard, 2001). The sampling was carried out along a vertical descent from the tree crown down to the base, in order to minimize disturbing the community of epiphytes associated with the tree, particularly lichens. Specimens were collected along the trunk and some branches. Johansson's zones were distinguished (Gradstein *et al*., 2003) (Fig. 2) and samples were taken from the side of the trunk displaying the highest lichen cover (Cáceres *et al*., 2007; Pérez-Pérez *et al*., 2015).

The specimens collected were preserved and determined following the protocols suggested by Brodo *et al.* (2001) and Nash III *et al.* (2002) in the Mycology Laboratory at *Instituto de Ecología, A.C.*, in the Lichenology Laboratory at the *Universidade Federal de Sergipe,* campus Itabaiana, and in the Integrated Laboratory of Plant Biology and Mycology at the School of Biology, *Benemérita Universidad Autónoma de Puebla*. Taxa nomenclature follows Kirk *et al*. (2008) and the Index Fungorum (2014) and MycoBank (Crous *et al*., 2004) databases. Vouchers are deposited in the XAL, ISE and BUAP herbaria.

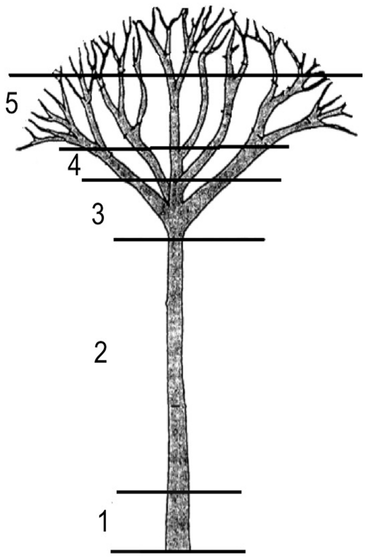


Fig. 2. Johansson's zones (modified from Gradstein *et al.*, 2003). 1) trunk base; 2) trunk; 3) base of the lowest branches; 4) intermediate branches; 5) outer branches (twigs).

*Data Analysis:* Species richness was estimated using the first-order Jackknife method with the statistical program PCOrd 5 (Neitlich & McCune, 1997; McCune & Grace, 2002). A $X^2$ test was performed to determine significant differences, if any, in species richness between phorophytes and between the different Johansson's zones. The indicator species analysis (ISA) was used to identify possible preferences of lichen species for some of the Johansson's zones (Neitlich & McCune, 1997; McCune & Grace, 2002).

## RESULTS

A total of 126 lichen species belonging to 60 genera, 24 families and 10 orders were identified on the 15 *Q. laurina* phorophytes studied. The first-order Jackknife estimator estimates that the lichen community could comprise 179 species, which indicates that our sampling included 70% of the lichen species potentially present in the phorophytes of the study area.

The taxonomic order with the greater number of lichen families was Lecanorales with nine, followed by Peltigerales with four families. As regards the number of genera, the best represented family was Graphidaceae with 11 genera, followed by Parmeliaceae with nine, Ramalinaceae, Physciaceae, and Trypetheliaceae with five, Arthoniaceae and Lecanoraceae with three, Pannariaceae and Roccellaceae with two, and 15 families with only one genus (Table 1).

From the 126 species, 21 were new records for Veracruz and 21 were reported here for the first time to Mexico (Table 1). The species *Astrothelium coccineum*, *Micarea viridicapitata*, and *Protoparmelia microspora* are worth noting, since they have been described just recently as new to science (Córdova-Chávez *et al.*, 2014).

Table 1. Lichen taxa associated with *Quercus laurina* at La Cortadura mountain cloud forest, Veracruz, Mexico

| *Species* | *Species* |
|---|---|
| **Arthoniaceae** | **Graphidaceae** |
| *Arthonia* sp. | *Graphis* sp. 1 |
| *Cryptothecia lichexanthonica* E.L. Lima, Aptroot & M. Cáceres** | *Graphis* sp. 2 |
| *Cryptothecia* sp. | *Hemithecium* sp. |
| *Herpothallon rubrocinctum* (Ehrenb.) Aptroot, Lücking & G. Thor | *Melanotrema* sp. |
| **Brigantiaeaceae** | *Myriotrema* sp. |
| *Brigantiaea leucoxantha* (Spreng.) R. Sant. & Hafellner | *Ocellularia albocincta* (Hale) Divakar & Mangold** |
| **Cladoniaceae** | *Ocellularia columellata* Zahlbr.** |
| *Cladonia didyma* (Fée) Vain. | *Ocellularia* sp. |
| **Coccocarpiaceae** | *Phaeographis* cf. *leiogrammodes* (Kremp.) Müll. Arg.* |
| *Coccocarpia palmicola* (Spreng.) Arv. & D.J. Galloway | *Phaeographis* cf. *tortuosa* (Ach.) Müll. Arg.** |
| *Coccocarpia pellita* (Ach.) Müll. Arg. | *Phaeographis dendritica* (Ach.) Müll. Arg. |
| **Collemataceae** | *Phaeographis* sp. |
| *Leptogium cyanescens* (Pers.) Körb.* | *Platythecium* sp. |
| ***Crocyniaceae*** | *Thelotrema conveniens* Nyl.** |
| *Crocynia gossypina* (Sw.) A. Massal.* | *Thelotrema foveolare* Müll. Arg.** |
| *Crocynia pyxinoides* Nyl | *Thelotrema spondaicum* Nyl.* |
| **Fissurinaceae** | **Lecanoraceae** |
| *Fissurina* sp. | *Lecanora helva* Stizenb.* |
| **Graphidaceae** | *Lecanora tropica* Zahlbr.* |
| *Acanthothecis* sp. | *Lecanora* sp. |
| *Chapsa* cf. *dilatata* (Müll. Arg.) Kalb** *Diorygma* sp. | *Lecidella* cf. *achristotera* (Nyl.) Hertel & Leuckert |
| *Graphis* cf. *distincta* Makhija & Adaw.** | *Traponora asterella* Aptroot** |
| *Graphis* cf. *streblocarpa* (Bél.) Nyl.** | **Lichenoconiaceae** |
| *Graphis* cf. *subdisserpens* Nyl.** | *Lichenoconium* sp. |
| *Graphis caesiella* Vain.* | **Lobariaceae** |
| *Graphis immersicans* A.W. Archer** | *Sticta* aff. *cometiella* Vain. |
| *Graphis librata* C. Knight | *Sticta* aff. *limbata* (Sm.) Ach. |
| *Graphis lumbricina* Vain.* | *Sticta beauvoisii* Delise |
| *Graphis marginata* Raddi** | **Malmideaceae** |
| *Graphis mexicana* (Hale) Kalb, Lücking & Lumbsch | *Malmidea hypomelaena* (Nyl.) Kalb & Lücking |
| *Graphis tenella* Ach. | *Malmidea* sp. |

Table 1. Lichen taxa associated with *Quercus laurina* at La Cortadura mountain cloud forest, Veracruz, Mexico (*continued*)

| *Species* | *Species* |
|---|---|
| **Megalosporaceae** | **Parmeliaceae** |
| *Megalospora sulphurata* Meyen | *Usnea* cf. *brasiliensis* (Zahlbr.) Motyka |
| **Ochrolechiaceae** | *Usnea* cf. *filipendulua* Stirt. |
| *Ochrolechia africana* Vain.* | *Usnea* cf. *mexicana* Vain. |
| **Pannariaceae** | *Usnea* cf. *subfloridana* Stirt. |
| *Leioderma* sp. | *Usnea* sp. |
| *Parmeliella clavulifera* P.M. Jørg. | **Pertusariaceae** |
| *Parmeliella imbricatula* (Müll. Arg.) P.M. Jørg.** | *Pertusaria* cf. *dilatata* Müll. Arg.** |
| **Parmeliaceae** | *Pertusaria* cf. *velata* (Turner) Nyl. |
| *Anzia americana* Yoshim. & Sharp* | *Pertusaria* sp. |
| *Anzia* cf. *ornata* (Zahlbr.) Asahina* | *Pertusaria velata* (Turner) Nyl.* |
| *Everniastrum cirrhatum* (Fr.) Hale ex Sipman* | *Pertusaria ventosa* Malme** |
| *Everniastrum vexans* (Zahlbr. Ex W.L. Culb. & C.F. Culb.) Hale ex Sipman | **Physciaceae** |
| *Flavoparmelia* cf. *rutidota* (Hook. F. & Taylor) Hale | *Cratiria aggrediens* (Stirt.) Marbach** |
| *Flavopunctelia* sp. | *Dirinaria applanata* (Fée) D.D. Awasthi* |
| *Hypotrachyna* cf. *brevirhiza* (Kurok.) Hale | *Dirinaria picta* (Sw.) Schaer. ex Clem.* |
| *Hypotrachyna* cf. *costaricensis* (Nyl.) Hale | *Heterodermia* cf. *granulifera* (Ach.) W.L. Culb.* |
| *Hypotrachyna* cf. *imbricatula* (Zahlbr) Hale | *Heterodermia* cf. *tropica* (Kurok.) Trass |
| *Hypotrachyna* cf. *neodissecta* (Hale) Hale | *Heterodermia appalachensis* (Kurok.) W.L. Culb. |
| *Hypotrachyna* cf. *pseudosinuosa* (Asahina) Hale | *Heterodermia* sp. |
| *Hypotrachyna* cf. *pulvinata* (Fée) Hale | *Physcia* cf. *caesia* (Hoffm.) Hampe ex Fürnr.* |
| *Hypotrachyna* cf. *sublaevigata* (Nyl.) Hale* | *Thelomma* sp. |
| *Hypotrachyna* sp. | ***Pilocarpaceae*** |
| *Parmotrema arnoldii* (Du Rietz) Hale | *Micarea viridicapitata* Córdova-Chávez, Aptroot & R.E. Pérez |
| *Parmotrema* cf. *grayanum* (Hue) Hale | **Pyrenulaceae** |
| *Parmotrema cristiferum* (Taylor) Hale | *Pyrenula dermatodes* (Borrer) Schaer.* |
| *Parmotrema flavescens* (Kremp.) Hale | **Ramalinaceae** |
| *Parmotrema mellissii* (C.W. Dodge) Hale | *Catinaria* sp. |
| *Parmotrema rampoddense* (Nyl.) Hale | |
| *Parmotrema reticulatum* (Taylor) M. Choisy | *Cliostomum* sp. |
| *Parmotrema* sp. 1 | *Eugeniella* sp. |
| *Parmotrema* sp. 2 | *Lopezaria versicolor* (Flot.) Kalb & Hafellner |
| *Parmotrema subisidiosum* (Müll. Arg.) Hale | *Phyllopsora* cf. *ochroxantha* (Nyl.) Zahlbr. |
| *Protoparmelia badiola* (Müll. Arg.) Kalb** | *Phyllopsora* sp. |
| *Protoparmelia microspora* Córdova-Chávez, Aptroot & M. Cáceres | *Phyllopsora swinscowii* Timdal & Krog |
| *Punctelia* cf. *bolliana* (Müll. Arg.) Krog | *Ramalina cf. sinaloensis* Bowler & Rundel* |
| *Punctelia hypoleucites* (Nyl.) Krog | *Ramalina* sp. |

Table 1. Lichen taxa associated with *Quercus laurina* at La Cortadura mountain cloud forest, Veracruz, Mexico (*continued*)

| *Species* | *Species* |
|---|---|
| **Roccellaceae** | *Bathelium degenerans* (Vain.) R.C. Harris* |
| *Opegrapha* sp. | *Mycomicrothelia miculiformis* (Nyl. ex Müll. Arg.) D. Hawksw.** |
| *Syncesia psaroleuca* (Nyl.) Tehler | *Polymeridium catapastum* (Nyl.) R.C. Harris** |
| *Syncesia* sp. | *Polymeridium sulphurescens* (Müll. Arg.) R.C. Harris |
| **Teloschistaceae** | *Trypethelium nitidiusculum* (Nyl.) R.C. Harris** |
| *Caloplaca* sp. | *Trypethelium* sp. |
| **Trypetheliaceae** | |
| *Astrothelium coccineum* Córdova-Chávez, Aptroot & M. Cáceres | |

* New records for Veracruz; ** New records for Mexico.

From all lichen species found, two (1.6%) were common to all trees (viz. *Herpothallon rubrocinctum* and *Punctelia hypoleucites*), 65 (51.6%) showed a preference for one of the 15 *Q. laurina* phorophytes, and 59 (46.8%) were shared between two or more, but not all phorophytes (Table 2). The mean number of species per tree was 24.5 (± 0.92, SE), and no statistically significant differences were observed in the species richness of lichens between *Quercus laurina* phorophytes ($X^2$ $p > 0.05$).

Table 2. Lichen species richness on *Quercus laurina* phorophytes, indicating how many species are unique and shared among phorophytes

| *Tree* | *Total richness* | *Single occurrence* | *Shared with other phorophytes* |
|---|---|---|---|
| 1 | 28 | 8 | 20 |
| 2 | 26 | 7 | 19 |
| 3 | 22 | 4 | 18 |
| 4 | 26 | 5 | 21 |
| 5 | 20 | 4 | 16 |
| 6 | 22 | 2 | 20 |
| 7 | 30 | 6 | 24 |
| 8 | 25 | 2 | 23 |
| 9 | 21 | 2 | 19 |
| 10 | 27 | 5 | 22 |
| 11 | 22 | 3 | 19 |
| 12 | 22 | 4 | 18 |
| 13 | 25 | 4 | 21 |
| 14 | 29 | 8 | 21 |
| 15 | 22 | 1 | 21 |

Table 3. Lichen species richness in the Johansson's zones considering the 15 *Quercus laurina* phorophytes, showing the number of unique and shared lichen species

| *Johansson's zones* | *Total richness* | *Single occurrence* | *Shared with other zones* |
|---|---|---|---|
| 1 | 41 | 10 | 31 |
| 2 | 50 | 12 | 38 |
| 3 | 49 | 12 | 37 |
| 4 | 60 | 14 | 46 |
| 5 | 56 | 18 | 38 |

As to the five Johansson's zones sampled in each of the 15 *Quercus laurina* phorophytes, 13 species (10.3%) were common to all zones, 66 (52.3%) showed a preference for a particular zone, and 47 (37.3%) were shared between two or more, but not all zones (Table 3). There were no differences in species richness between the different Johansson's zones ($X^2$, $p > 0.05$); however, all *Q. laurina* trees had 1 to 8 unique species per phorophyte.

Of the total number of lichen species, 75 were crustose, 44 foliose, six fruticose and one was a dimorphic lichen. Except for the dimorphic lichen, all other forms occurred in the five Johansson's zones of the studied trees, although crustose lichens were the most frequent growth form (Fig. 3). However, considering only the species that preferred a particular tree zone, zone one (trunk base) stands out, where crustose lichens were slightly less frequent than foliose lichens, being the only zone where *Cladonia didyma,* a dimorphic lichen, was found. Crustose lichens preferred zone two (trunk); foliose lichens were observed more frequently in zones three, four and five, and the fruticose lichens *Ramalina* sp. and *Usnea* sp. were found in all the five zones. In addition to the lichen species richness by zones, the results of the ISA analysis showed that only *Everniastrum vexans* and *Lecanora* sp. were significant to zone 1, *Parmotrema subisidiosum* to zone 2, *Punctelia hypoleucites* to zone 4, while *Ramalina* cf. *sinaloensis* was significant to zone 5.

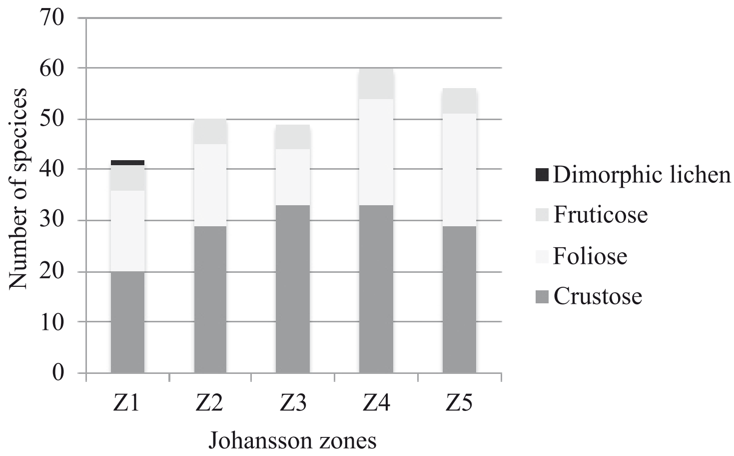


Fig. 3. Lichen species richness by biological form in Johansson's zones of *Quercus laurina* phorophytes.

## DISCUSSION

Although a number of studies have contributed to the documentation of the lichen flora of Mexico, these have addressed lichens present in different substrates and phorophytes; when sampling has included trees, the recording of species has reached only up to 2 m in trunk height (Zambrano *et al*., 2000; Pérez-Pérez *et al*., 2008; Pérez-Pérez *et al*., 2015). For this reason, the present work is pioneer in Mexico, since we studied the community of corticolous lichens along the vertical gradient of microhabitats in oak trunks. Besides, the study focused on *Quercus laurina* — one of the dominant trees in MCF at La Cortadura Reserve. Oak trees (*Quercus* spp.) are suitable hosts for vascular epiphytes (Hietz & Hietz-Seifert, 1995; Castro-Hernández *et al*., 1999). Oak bark is an important substrate for many epiphytic lichens (Johansson *et al*., 2009), and their presence is seemingly related to tree size and age (Lukošienė & Naujalis 2006). Johansson *et al*. (2009) suggest that preserving old *Quercus* trees is essential, especially when the regeneration rate of the forest is low and the survival of epiphytic lichens is threatened (Johansson *et al*., 2014).

Comparing our results with other studies is a complex issue because these generally differ in the sampling unit used or in sample size (Wolf *et al*., 2009), and do not include the same ecosystems. Aragón *et al*. (2010) reported 120 species of epiphytic lichens on 4590 trees sampled in 306 Mediterranean forests in which the dominant tree species was *Quercus ilex* ssp. *Ballota*; Kubiak (2006) reported 63 lichen species collected from 16 specimens of *Quercus rubra* L.; and Tore & Öztürk (2009) found 85 lichen species on seven *Quercus* species.

Pérez-Pérez *et al*. (2015) studied the lichen community growing on 129 phorophytes (13 tree species) in La Cortadura Reserve, finding 108 species on trunks at a height between 0.30 and 2 m, with *Q. laurina* being the tree species with the greatest lichen diversity (35 species). The present study reports 18 species not found by Pérez-Pérez *et al*. (2015), despite that they conducted a more extensive sampling (number and species of trees); however, these authors focused mostly on macrolichens, with some incidental collecting of microlichens.

Our study confirms that frequency and richness of the lichen communities in trunks of *Quercus* spp. are determined by a shift of ecological factors along the tree base-crown environmental gradient, as suggested by Lukošienė & Naujalis (2006) and Tore & Öztürk (2009). As height increases, moisture drops and desiccation by wind exposure increases; as a result, given that not all species tolerate desiccation equally well, the distribution of epiphytic lichens on phorophytes is highly unequal (Ellyson & Sillett, 2003). This fact was particularly evident in the crustose lichens recorded, the growth form that better resists the adverse conditions in the high zones of trees, as well as in some foliose (*Parmotrema* spp.) and fruticose (*Ramalina* sp. and *Usnea* sp.) lichens. Other sensitive species, such as those belonging to the genus *Sticta*, were recorded only in low zones where moisture is higher (Kumar *et al*., 2009; Moncada *et al*., 2014; this study), although species of the genus *Usnea* were found throughout the different zones of the tree.

According to Stone (1989) and Johansson *et al.* (2009) collecting samples of phorophytes of different ages and from different orientations of the trunk is also important, since the structure of oak bark changes with age, and orientation with slopes, so that succession processes may occur: young oaks may be colonized by generalist lichens, but as they grow old the community of epiphytic lichens may shift towards a more specific one. The effects of tree age in *Quercus laurina* stands will be an interesting continuation of our study.

Ranius *et al.* (2008) point out that many crustose lichens are associated with mature *Quercus* trees because the presence of the former depends on the depth of cracks in the bark. Other studies also indicated that crustose lichens are the most common in mature trees (Pray & Öztürk, 2012; Rosabal *et al.*, 2012). Accordingly, in the present study, the results indicate that crustose lichens were the most frequent, this may be because the selected phorophytes have a DBH < 40 cm, which corresponds to adult trees. Fifteen of the 42 new records reported here belong to the family Graphidaceae, the one with the highest diversity of crustose lichens (Herrera-Campos *et al.*, 2014); besides, these results highlight the need to make detailed inventories in the MCF stands that still remain. Accumulation of the results of both the present study and the work by Pérez-Pérez *et al.* (2015) yields a total of 205 species and 77 genera, with Parmeliaceae and Graphidaceae as the most diverse families. This indicates that the MCF at La Cortadura Reserve supports a highly diverse lichen community; thus, more extensive explorations, including other tree species, will enable to understand the relationship of lichen communities with phorophytes and the ecological role of the former in the ecosystem.

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