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New records of aphyllophoroid fungi from Aguascalientes, Mexico and an approach to their ecological preferences

Nuevos registros de hongos afiloforoides de Aguascalientes, México y una aproximación a sus preferencias ecológicas

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Abstract. Little is known of wood-inhabiting aphyllophoroid fungi in some Mexican territories. The State of Aguascalientes is an example: there have been few records of these fungi until now. The main objective of this study is to provide a preliminary inventory of the wood-inhabiting aphyllophoroid species of the state. The fieldwork was carried out by sampling the principal plant communities during the main period of basidiomata production in 2011. A preliminary list of 81 species is presented, 55 of these recorded for the first time in the state. Additionally, a non-metric multidimensional scaling (MDS) analysis was conducted to explore the fungal communities. Based on the vegetation, 3 significantly differentiated aphyllophoroid community groups were identified: temperate forests, scrublands and deciduous tropical forest. The highest species richness was found in oak forests.

Key words: Aphyllophoroid community, corticioid fungi, fungal diversity, plant community, polyporoid fungi.

Resumen. Los hongos afiloforoides lignícolas están poco estudiados en algunos territorios de México. El estado de Aguascalientes es un ejemplo de ello, ya que hasta ahora poseía escasas citas de estos hongos. El objetivo principal de este trabajo fue hacer un inventario preliminar de hongos afiloforoides lignícolas para el territorio. Para ello se muestrearon varios tipos de comunidades vegetales durante el periodo óptimo para la producción de basidiomas de los hongos en 2011. Se presenta una lista de 81 especies, de las cuales 55 son nuevas citas para el estado. Para analizar la comunidad fúngica con base en la vegetación, se aplicó el método de análisis de escalamiento multidimensional no métrico (MDS) con el que se formaron 3 grupos significativos: los bosques templados, los matorrales y la selva baja caducifolia. Asimismo, cabe señalar que el bosque de encino fue la comunidad vegetal con mayor riqueza en especies estudiadas.

Palabras clave: Comunidad de afiloforoides, hongos corticioides, diversidad fúngica, hongos poliporoides, comunidad vegetal.

Introduction

The few studies that exist for wood-inhabiting fungi in Mexico are quite recent. Interest in studying these organisms has recently increased, as wood-inhabiting fungi are an ecologically important and highly diverse group (Stokland et al., 2012). Furthermore, the wide variety of landscapes in Mexico suggests that wood-inhabiting fungi may be highly diverse. In fact, it has been observed that high woody plant diversity is related to a high diversity of wood-inhabiting fungal species (Heilmann-Clausen et al., 2005; Unterseher et al., 2005). The diversity of the aphyllophoroid fungi is known to be influenced by several factors, of which host species diversity is one of the most important (Ódor et al., 2006). Actually, wood-inhabiting fungal species are very specific to their hosts, and fungal communities are significantly different depending on the vegetation type (Heilmann-Clausen et al., 2005; Unterseher et al., 2005). Thus, wood-inhabiting fungi represent one of the most diverse groups of wood-decaying organisms (Stokland et al., 2012). The most frequent wood-inhabiting fungal species belong to the Basidiomycota, including 2 main groups: polyporoid and corticioid fungi. These 2 groups have traditionally been placed in the order Aphyllophorales, but the molecular approach has drastically changed this

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classical classification (Hibbett et al., 2007; Matheny et al., 2007).

Concerning studies on Mexican fungi published to date, e.g. Valenzuela et al. (2002, 2004, 2005, 2006, 2010, 2012a and 2012b), Raymundo and Valenzuela (2003), Montaño et al. (2006), Marmolejo and Méndez-Cortes (2007), Raymundo et al. (2009), Amalfi et al. (2012), Contreras-Pacheco et al. (2012) and Salinas-Salgado et al. (2012). It is worth mentioning that although a large number of new records of fungi species have been published, some fungal groups and some parts of Mexico have not been thoroughly explored. This is the case of some aphyllophoroid fungi, and particularly corticioid fungi, which have not been properly studied until now. Among the territories not studied in depth, the state of Aguascalientes stands out: although it is an important area with numerous protected sites, few mycological studies have been conducted. According to our bibliographic resources, the only published work on Aguascalientes (Pardavé et al., 2007) reports 342 mushroom species, of which 46 were polyporoid and only 2 were corticioid.

Aguascalientes is located in the center of Mexico, and has 2 climate types: it is mostly arid, but in the western mountains, areas of temperate climate can be found (Inegi, 2008). These climates have generated a variety of vegetation types in the state. Based on species dominance, Rodríguez et al. (2011) classifies 28 types of natural plant communities in Aguascalientes, the main ones being needle leaf, mixed and broadleaf forest, high scrubland, deciduous tropical forest, subtropical scrubland, arid open forest, arid and semiarid scrubland. The principal genera of trees and bushes in the state are *Quercus*, *Pinus*, *Juniperus*, *Arbutus*, *Arctostaphylos*, *Acacia*, *Ipomoea*, *Prosopis, Yucca* and *Opuntia*. In an attempt to preserve the natural resources of Aguascalientes, 25% of the territory has been placed under some degree of official protection (Lozano and Estrada, 2008). The following sites have been designated as natural parks: Sierra Fría (112 090 ha), Sierra del Laurel (19 195 ha), Cerro del Muerto (5 862 ha) and Serranía Juan Grande (2 589 ha).

Considering the high vegetation diversity, the number of protected areas in Aguascalientes and the fact that wood-inhabiting aphyllophoroid fungi are a relatively unexplored group in the territory, the objectives of this study are: *1)* to provide a preliminary inventory of the wood-inhabiting aphyllophoroid species for the state, and *2)* to compare the aphyllophoroid communities of the plant communities sampled.

Materials and methods

The study plots were located in the following different localities and municipalities of the state of Aguascalientes: San José de Gracia (Sierra Fría, Cerro El Colorín, Cerro de la Calavera, Rancho Peña Azul), Calvillo (Sierra del Laurel, Presa de los Serna, Palo Alto, El terrero de los López), Aguascalientes (El Ocote), Jesús María (Cerro del Muerto, Gracias a Dios, Milpillas, Tapias Viejas, Presa Los Arquitos) and El Llano (Serranía Juan Grande). The sites studied were grouped according to their matching proximity and vegetation type (Appendix). The geographical coordinates of the plots are displayed on the map of vegetation of Aguascalientes (Fig. 1).

The fieldwork was carried out in 2011, during the most favorable period for basidomata production (from July to September). Basidiomata collected were placed in paper bags in the field, and then dried and frozen for 72 hours in the laboratory. The date, locality, type of vegetation and host species data were recorded for each specimen. The dried material was identified by microscopic analyses using a Nikon light microscope. The preparations were made in Congo red KOH 5%, Melzer's reagent, and sulphovanilline. Voucher specimens have been deposited in the BIO-Fungi Herbarium in the University of the Basque Country (Spain).

Species were identified mostly following Eriksson and Ryvarden (1973, 1975, 1976); Eriksson et al. (1978, 1981, 1984); Breitenbach and Kränzlin (1986); Gilbertson and Ryvarden (1986); Hjortstam et al. (1987, 1988); Tellería and Melo (1995); Bernicchia (2005); Bernicchia and Gorjón (2010). Specific literature was consulted, such as Burdsall (1985); Langer (1994); Kõljalg (1996); Núñez

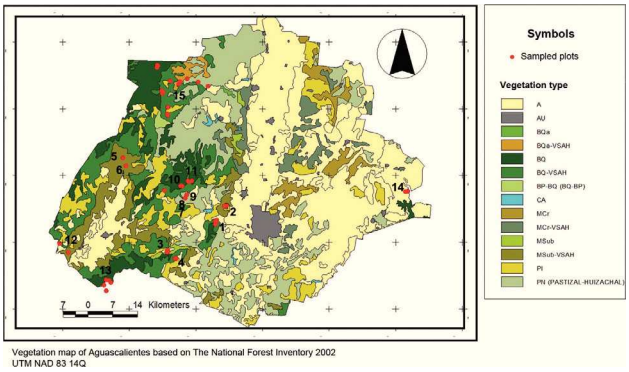

Figure 1. Vegetation map of Aguascalientes. The sites where samples were collected are indicated by red points. Legend: A: agriculture, AU: urban area, BQa: open oak forest, BQa-VSAH: disturbed oak forest, BQ: oak forest, BQ-VSAH: disturbed oak forest, BP-BQ (BQ-BP): pine-oak forest, CA: water, MCr: arid scrubland, MCr-VSAH: disturbed arid scrubland, MSub: subtropical scrubland, MSub-VSAH: disturbed subtropical scrubland, PI: induced prairie, PN: natural prairie with *Acacia.*

and Ryvarden (1997); Léger (1998); Boidin and Gilles (1988). Fungal names were updated according to Index Fungorum (2013) (www.indexfungorum.org).

Species richness (S) and the Shannon diversity index [H'= -Σpi Ln (pi)] were calculated to explore and compare the number of species found in the different types of vegetation. Similarly, multivariate analysis was carried out to evaluate and compare aphyllophoroid communities, using the PRIMER 6 software package (Clarke and Gorley, 2006). As well, the Bray-Curtis resemblance index was used to gauge the similarity of aphyllophoroid communities (Clarke and Warwick, 2001). A non-metric multidimensional scaling (MDS) analysis was conducted to observe the grouping of aphyllophoroid communities of the different plant communities based on presence/absence data. Cluster classification analysis was also superimposed on the MDS to show the percentage of similarity between aphyllophoroid communities. Finally, a Simprof permutation test was run to find statistical differences between the groups formed.

Results

In total, 308 specimens were collected during the sampling period, from which 81 species were identified (Table 1). These species belonged to 43 genera, distributed into 18 families and some species in *Incertae sedis*. The best-represented families were *Phanerochaetaceae* Jülich (with 14 species), *Meruliaceae* P. Karst. (12 species), *Polyporaceae* Fr. ex Corda (10) and *Hymenochaetaceae* Lév. (8). *Phanerochaete* P. Karst. and *Hyphoderma* Wallr. were the genera with the highest number of recorded species

Table 1. List of species found in this study, showing the location and the substrate where they were found. *New records for Aguascalientes

Family	*Species*	*Site code (Appendix)*	*Substrate*	*BIO-Fungi herbarium number*
Amylocorticiaceae	**Ceraceomyces* cf. *sulphurinus* (P. Karst.) J. Erikss. and Ryvarden 1978	(12,2)	*Ceiba* sp.	16971
	**Ceraceomyces serpens* (Tode) Ginns 1976	(13,1)	*Quercus potosina* Trel. 1924	16641
Atheliaceae	**Athelia acrospora* Jülich 1972	(13,1), (9,1)	*Quercus* sp., *Q. potosina*	16661, 16877
	**Athelia bombacina* (Link) Pers. 1822	(15,2)	*Juniperus deppeana* Stend. 1840	16505
	**Athelia pyriformis* (M.P. Christ.) Jülich 1972	(3,1)	*Opuntia* sp.	16879
Auriculariaceae	**Eichleriella* cf. *leucophaea* Bres. 1903	(15,3), (7,1), (11,1)	*Arctostaphylos pungens* Kunth 1818, *Quercus grisea* Liebm 1854	16977, 16975, 16976
Coniophoraceae	**Coniophora arida* (Fr.) P. Karst. 1868	(15,3)	*Juniperus deppeana*	16529
Corticiaceae	**Dendrothele commixta* (Höhn. and Litsch.) J. Erikss. and Ryvarden 1975	(15,3)	*Juniperus* sp.	16509
	**Mutatoderma brunneocontextum* C.E. Gómez 1976	(13,1)	*Quercus eduardii* Trel. 1922	16655
	**Vuilleminia comedens* (Nees) Maire 1902	(14,1)	*Quercus grisea*	16628
Fomitopsidaceae	*Antrodia serialis* (Fr.) Donk 1966	(10,1)	*Pinus* sp.	16558
Ganodermataceae	*Ganoderma applanatum* (Pers.) Pat. 1887	(15,3)	*Quercus grisea*	16549
Hydnodontaceae	**Fibrodontia gossypina* Parmasto 1968	(12,2)	Unknown	16542
	**Subulicystidium perlongisporum* Boidin and Gilles 1988	(12,2)	*Myrtillocactus geometrizans* (Mart. Ex Pfeiff.) Console 1897	16545
	**Trechispora microspora* (P. Karst.) Liberta 1966	(15,5)	*Pinus durangensis* Martínez 1942	16520

Table 1. Continues

Family	*Species*	*Site code (Appendix)*	*Substrate*	*BIO-Fungi herbarium number*
Hymenochaetaceae	*Fuscoporia contigua* (Pers.) G. Cunn. 1948	(13,1)	*Quercus* sp.	16859
	Fuscoporia ferrea (Pers.) G. Cunn. 1948	(15,5)	*Quercus resinosa* Liebm 1854	16524
	Inonotus quercustris M. Blackw. and Gilb. 1985	(3,1)	*Quercus* sp.	16626
	Phellinus conchatus (Pers.) Quél. 1886	(1,2)	*Quercus resinosa*	16578
	Phellinus rimosus (Berk.) Pilát 1940	(4,1), (3,1), (12,1)	*Acacia* sp., *A. farnesiana* (L.) Willd. 1806	16547, 16548, 16620, 16621
	Phellinus sp.	(4,2)	*Quercus resinosa*	16942
	Pseudochaete tabacina (Sowerby) T. Wagner and M. Fisch. 2002	(15,3), (13,1)	*Quercus potosina*	16875
	**Tubulicrinis calothrix* (Pat.) Donk 1956	(15,7), (9,2)	*Pinus* sp.	16540, 16612
Incertae sedis	**Peniophorella praetermissa* (P. Karst.) K.H. Larss. 2007	(15,3), (13,1), (8,1), (11,2)	*Quercus* sp., *Q. eduardii, Q. resinosa.*	16504, 16562, 16587, 16644
	**Peniophorella* aff. *pubera* (Fr.) P. Karst. 1889	(15,2)	*Quercus* sp.	16893, 16894
	**Trichaptum fuscoviolaceum* (Ehrenb.) Ryvarden 1972	(10,1)	*Pinus* sp.	16559
Meripilaceae	*Rigidoporus crocatus* (Pat.) Ryvarden 1983	(6,1)	Unknown	16633
Meruliaceae	**Cabalodontia* cf. *queletii* (Bourdot and Galzin) Piątek 2004	(9,1)	*Quercus potosina*	16895
	**Hyphoderma cremeoalbum* (Höhn. and Litsch.) Jülich 1974	(15,3), (8,1), (14,1)	*Arctostaphylos pungens, Quercus grisea, Q. potosina*	16533, 16584, 16630
	**Hyphoderma litschaueri* (Burt) J. Erikss. and Å. Strid 1975	(15,2/15,3/15,7), (11,1/11,2), (13,1), (8,1), (7,1), (11,1)	*Arctostaphylos pungens, Quercus* sp., *Q. eduardii, Q. grisea, Q. potosina, Q. resinosa*	16506, 16510, 16514, 16536, 16556, 16569, 16592, 16595
	**Hyphoderma setigerum* (Fr.) Donk 1957	(12,2), (1,2), (7,1)	*Quercus* sp., *Q. potosina*	16541, 16571, 16594
	**Hyphoderma sibiricum* (Parmasto) J. Erikss. and Å. Strid 1975	(13,1), (1,2), (7,1)	*Arctostaphylos pungens, Quercus eduardii, Q. potosina*	16572, 16602, 16658
	Hyphoderma sp.	(13,1)	*Quercus potosina*	16883
	**Phlebia livida* (Pers.) Bres. 1897	(11,1), (8,1), (7,1), (9,1)	*Arctostaphylos pungens, Quercus potosina, Q. resinosa*	16563, 16588, 16600, 16603, 16605
	**Phlebia rufa* (Pers.) M.P. Christ. 1960	(13,1)	*Quercus* sp.	16663
	**Steccherinum ciliolatum* (Berk. and M.A. Curtis) Gilb. and Budington 1970	(15,6)	Unknown	16522
	**Steccherinum litschaueri* (Bourdot and Galzin) J. Erikss. 1958	(15,3)	*Juniperus deppeana*	16507
	**Steccherinum ochraceum* (Pers.) Gray 1821	(13,1)	*Quercus* sp., *Q. eduardii, Quercus potosina*	16647, 16651, 16657, 16664
	**Steccherinum oreophilum* Lindsey and Gilb. 1977	(13,1)	*Quercus eduardii*	16613, 16650

Table 1. Continues

Family	*Species*	*Site code (Appendix)*	*Substrate*	*BIO-Fungi herbarium number*
Peniophoraceae	**Peniophora albobadia* (Schwein.) Boidin 1961	(1,1), (15,3), (13,1), (9,2), (6,1), (2,1), (7,1), (11,1), (4,1), (3,1), (14,1)	*Acacia farnesiana, Arctostaphylos pungens, Prosopis laevigata* (Willd.) M.C. Johnst. 1962*, Quercus* sp.*, Q. grisea, Q. potosina, Q. resinosa*	16618, 16619, 16623, 16624, 16629, 16636, 1663716530, 16535, 16577, 16577, 16565, 16570, 16599, 16609, 16645, 16661
	**Peniophora* aff. *nuda* (Fr.) Bres. 1897	(15,3)	*Quercus* sp.	16890, 16891, 16892
	**Peniophora quercina* (Pers.) Cooke 1879	(15,3)	*Quercus potosina*	16516
Phanerochaetaceae	**Hyphodermella corrugata* (Fr.) J. Erikss. and Ryvarden 1976	(12,2)	Unknown	16543
	**Phanerochaete aculeata* Hallenb. 1978	(6,1)	Unknown	16635
	**Phanerochaete calotricha* (P. Karst.) J. Erikss. and Ryvarden 1978	(15,3), (13,1)	*Arctostaphylos pungens, Quercus* sp.*, Q. potosina*	16513, 16646, 16648, 16665
	**Phanerochaete* cf. *cacaina* (Bourdot and Galzin) Burds. and Gilb. 1974	(5,1)	*Ipomoea murucoides* Roem. and Schult. 1819	16631
	**Phanerochaete chrysosporium* Burds. 1974	(8,1), (15.3)	*Juniperus deppeana, Quercus resinosa*	16528, 16591
	**Phanerochaete deflectens* (P. Karst.) Hjortstam 1987	(1,2)	*Quercus* sp.	16574
	**Phanerochaete galactites*(Bourdot and Galzin) J. Erikss. and Ryvarden 1978	(15,1/15,3/15,7) (11,1), (1,2), (7,1)	*Arctostaphylos pungens, Juniperus deppeana, Quercus eduardii, Q. potosina, Q. resinosa*	16501, 16503, 16531, 16538, 16554, 16564, 16568, 16573, 16576, 16579, 16585, 16597, 16601, 16616, 16616
	**Phanerochaete laevis* (Fr.) J. Erikss. and Ryvarden 1978	(15,2/15,3), (9,1/9,2), (13,1)	*Quercus* sp.*, Q. potosina*	16511, 16534, 16537, 16606, 16610, 16662
	**Phanerochaete sordida* (P. Karst.) J. Erikss. and Ryvarden 1978	(15,2), (9,2), (13,1)	*Quercus* sp.*, Q. potosina*	16512, 16614, 16656
	**Phanerochaete velutina* (DC.) P. Karst. 1898	(11,2)	*Quercus* sp.	16553, 16560
	**Phanerochaete xerophila* Burds. 1985	(9,2), (13,1)	*Quercus* sp.	16607, 16608, 16667
	Phlebiopsis sp.	(13,1)	*Quercus eduardii*	16935
	**Porostereum crassum* (Lév.) Hjortstam and Ryvarden 1990	(8,1), (6,1), (2,1)	*Quercus resinosa*	16575, 16589, 16593, 16634
	**Rhizochaete radicata* (Henn.) Gresl., Nakasone and Rajchenb. 2004	(3,1)	*Forestiera phillyreoides* (Benth.) Torr. 1858	16622
Polyporaceae	*Dichomitus campestris* (Quél.) Domański and Orlicz 1966	(1,2)	*Quercus* sp.	16581
	Perenniporia meridionalis Decock and Stalpers 2006	(15,7)	*Quercus* sp.	16526

Table 1. Continues

Family	*Species*	*Site code (Appendix)*	*Substrate*	*BIO-Fungi herbarium number*
	Perenniporia sp.	(13,1)	*Arctostaphylos pungens*	16939
	Perenniporia subacida (Peck) Donk 1967	(7,1)	*Quercus* sp.	16598
	Polyporus alveolaris (DC.) Bondartsev and Singer 1941	(15,7)	Unknown	16936
	Polyporus cf. *meridionalis* (A. David) H. Jahn 1980	(12,2)	Unknown	16551
	Skeletocutis cf. *ochroalba* Niemelä 1985	(13,1), (7,1)	*Arctostaphylos pungens*	16680, 16681
	Skeletocutis nivea (Jungh.) Jean Keller 1979	(11,2)	*Quercus* sp.	16557
	Skeletocutis percandida (Malençon and Bertault) Jean Keller 1979	(15,6/15,2/15,4)	*Juniperus deppeana, Quercus* sp.	16523, 16527
	Trametes aff. *ochracea* (Pers.) Gilb. and Ryvarden 1987	(4,1)	*Forestiera phillyreoides*	16978
Schizoporaceae	**Hyphodontia abieticola* (Bourdot and Galzin) J. Erikss. 1958	(15,4/15,5)	*Pinus durangensis*	16518, 16519
	**Hyphodontia aspera* (Fr.) J. Erikss. 1958	(10,1), (11,2)	*Arctostaphylos pungens*	16555, 16561
	**Hyphodontia nespori* (Bres.) J. Erikss. and Hjortstam 1976	(15,2/15,3)	*Arctostaphylos pungens, Quercus obtusata* Bonpl. 1809*, Q. potosina*	16515, 16525, 16533
	Hyphodontia radula (Pers.) Langer and Vesterh. 1996	(13,1), (15,6)	*Quercus eduardii, Q. grisea*	16539, 16639
	**Xylodon pruni* (Lasch) Hjortstam and Ryvarden 2007	(12.2)	Unknown	16544
	Schizopora paradoxa (Schrad.) Donk 1967	(8,1), (6,1), (13,1)	*Arctostaphylos pungens, Quercus* sp.*, Q. eduardii, Q. resinosa*	16590, 16632, 16643, 16653, 16654, 16666
Stephanosporaceae	**Lindtneria chordulata* (D.P. Rogers) Hjortstam 1987	(13,1)	*Quercus eduardii*	16960, 16957
Stereaceae	**Acanthophysellum minor* (Pilát) Sheng H. Wu, Boidin and C.Y. Chien 2000	(12,2)	Unknown	16546
	**Aleurodiscus thujae* Ginns 1990	(15,6)	*Juniperus deppeana*	16517
	**Stereum ochraceoflavum* (Schwein.) Sacc. 1888	(15,3), (9,1)	*Quercus* sp.*, Q. potosina*	16502, 16508, 16604
	**Stereum reflexulum* D.A. Reid 1969	(11,1), (9,2), (15,3), (13,1)	*Quercus* sp.*, Q. eduardii, Q. potosina*	16566, 16611, 16642, 16652, 16887
	Stereum cf. *rugosum* Pers. 1794	(15,3)	*Quercus eduardii*	16888
	Stereum hirsutum (Willd.) Pers. 1800	(15,3/15,4)	*Juniperus deppeana, Quercus potosina*	16521, 16532
	Stereum sp.	(13,1)	*Quercus* sp.	16956
Thelephoraceae	**Tomentella umbrinospora* M.J. Larsen 1963	(1,2), (4,2), (13,1)	*Quercus* sp.*, Q. potosina, Q. resinosa*	16580, 16582, 16583, 16617

(10 and 5 respectively). The most frequent species were *Phanerochaete galactites* (Bourdot and Galzin) J. Erikss. and Ryvarden (20 specimens), *Peniophora albobadia* (Schwein.) Boidin (17), *Hyphoderma litschaueri* (Burt) J. Erikss. and Å. Strid (15) and *Schizopora paradoxa* (Schrad.) Donk (10).

Among the species studied, 55 are recorded for the first time in the state of Aguascalientes, and these are indicated by an asterisk in Table 1. Likewise, most of these are little known in the remaining Mexican states.

The genus *Quercus* had significantly more aphyllophoroid species than substrates of other genera. However, when the host species were analyzed one by one, *Arctostaphylos pungens, Quercus eduardii* and *Q. potosina,* were found to be the species that held most aphyllophoroid species (Table 2). Similarly, the highest fungal diversity was found in oak forest with 37 species and a diversity of 3.6 (H'= 3.6), followed by disturbed oak forest with 21 species and H'= 3.0 (Table 3). By contrast scrubland, deciduous tropical forest and juniper forest had the lowest fungal diversity with less than 10 species and H'< 2.2 each (Table 3).

Oak forest and disturbed oak forest had the highest number of fungal species and families (Fig. 2), while subtropical scrubland forest, juniper forest and arid scrubland had the lowest species and family richness.

Table 2. Number of species found per substrate

Substrate	*Number of species (S)*
Acacia sp.	4
Arctostaphylos pungens	14
Ceiba sp.	1
Forestiera philyreoides	1
Ipomoea murucoides	1
Juniperus sp.	9
Myrtillocactus geometrizans	1
Opuntia sp.	1
Pinus sp.	5
Prosopis laevigata	1
Quercus eduardii	16
Q. grisea	7
Q. obtusata	1
Q. potosina	22
Q. resinosa	11
Quercus spp.	34
Unknown	27

Table 3. Species and family richness, and Shannon diversity index (H') for each plant community

Plant communities	*Species richness (S)*	*Shannon index (H'loge)*	*Families richness (S)*
Oak forest	37	3.6109	15
Disturbed oak forest	21	3.0445	10
Juniper-oak forest	15	2.7080	10
Pine-oak forest	14	2.6390	8
Mixed forest	11	2.3978	6
Arid scrubland	9	2.1972	8
Deciduous tropical forest	8	2.0794	6
Disturbed pine-oak forest	7	1.9459	6
Juniper forest	7	1.9459	5
Subtropical scrubland	7	1.9459	5

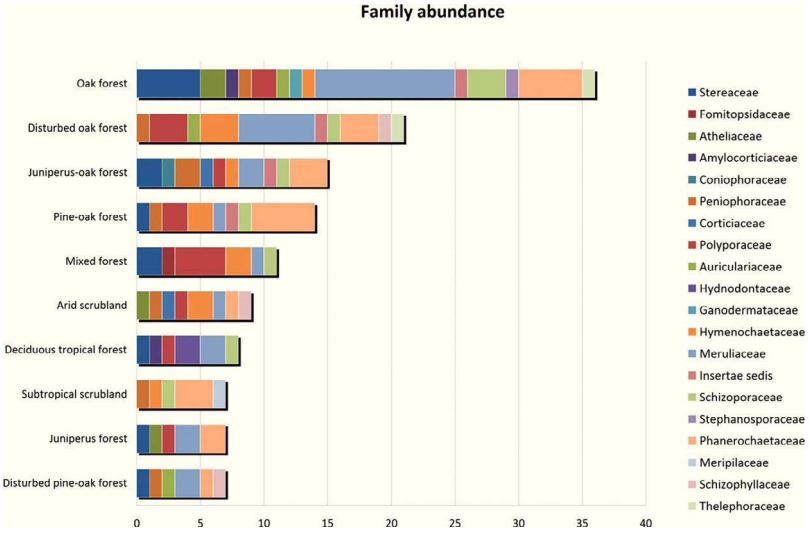

Figure 2. Number of species found in each plant community. Species belonging to the different families are represented by different colours.

Nevertheless, the plant communities with the highest species diversity had a lower family/species proportion value than the plant communities, which denotes a lower species diversity. That is, in the subtropical scrubland, juniper forest and arid scrubland the probability of a species belonging to a different family was found to be higher than in oak forest and disturbed oak forest. In fact, almost all of the species found in these plant communities belonged to different families.

In the MDS analysis, 3 significantly differentiated groups were identified by the Simprof procedure (Fig. 3). The principal factor for the differentiation of fungal composition was the woody species of the different plant communities. In fact, the plant communities with *Quercus* species constituted one distinct group, those with scrub species formed another and those with tropical species comprised a third. Likewise, within each group the similarity of the aphyllophoroid communities was higher when more woody species were shared.

Regarding the species composition of the different plant communities, temperate forests have in common some species that are known as cosmopolites. Examples include *H. litschaueri*, *Peniophorella praetermissa*, *Phanerochaete galactites*, *P. laevis* (Fr.) J. Erikss. and Ryvarden and *P. sordida* (P. Karst.) J. Erikss and Ryvarden.

Discussion

Although the fieldwork for this study was carried out within a year, 81 species were identified. According to our data, 55 species were recorded for the first time in the area (these species are marked with an asterisk in Table 1).

Different patterns of species distribution were observed. Many of the species documented have a wide distribution, and occur in most continents, e.g. *P. praetermissa, P. sordida* and *S. paradoxa,* which are well known from deciduous forests and occur on a wide range of substrates (Breitenbach and Kränzlin, 1986). Other species are exclusive to the Americas, such as *Inonotus quercustris*, which is known from the USA on *Quercus nigra* (Gilbertson and Ryvarden, 1986); from Mexico in Querétaro State on *Quercus* sp. (Valenzuela et al., 2013) and from Argentina on *Lithraea ternifolia* and on *Acacia caven* (Urcelay and Rajchenberg, 1999). Likewise, *P. albobadia* has been recorded from Mexico, USA, Central and South America on several substrates (Nakasone, 1990). Finally, other species that have previously been considered as American are currently being cited in other territories, e.g. *Phanerochaete xerophila* Burds., which has been reported by Burdsall (1985) as a common species from the Sonoran Desert, growing on dead fallen branches of shrubs, cacti and on *Prosopis velutina*. In our study we found this species on *Quercus* sp. in oak and pine-oak forests. The same species has also been reported from Uruguay on *Scutia buxifolia* (Martínez and Nakasone 2005) and from Cabo Verde on *Sarcostenma daltonii*, *Prosopis* sp., and on *Phoenix atlantica* (Tellería pers. comm.). Another example is *Porostereum crassum*, which is a common species in America and was first reported from Spain by Salcedo and Olariaga (2008). The number of aphyllophoroid species was found to be higher in temperate forests than in scrublands. This could be partially explained by the exceptionally dry conditions of the sampling year. In fact, the scrublands were particularly affected that year, while forests conserved more humid conditions required for basidiomata production. Thus, few specimens were gathered in scrublands and those collected were mostly in poor condition for identification. Therefore, the potential of scrublands to host mycobiota could be higher than observed in this study.

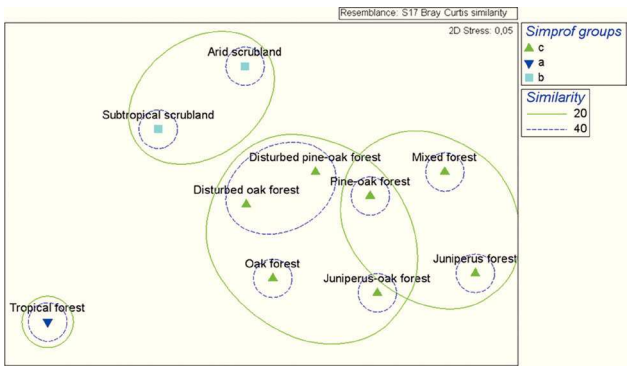

Figure 3. MDS ordination of plant communities sampled based on the aphyllophoroid species composition.

The MDS result was expected, as most fungal species are specific to their host (Stokland et al., 2012). The similarities in terms of woody plant composition between the different plant communities were reflected in the structure of the aphyllophoroid community. The first group identified corresponded to temperate forest formations, which share many woody plant species (e. g. *Quercus* spp., *Arctostaphyllos pungens*, etc.) and also have similar climate conditions that influence the fungal guild structure. Most of the species that appeared in all the temperate forest plant communities have a cosmopolitan distribution, e.g. *H. litschaueri*, *P. praetermissa* and *P. galactites* (Bernicchia and Gorjón, 2010). The second group, formed by arid and subtropical scrublands, also shares some species (cacti, *Acacia* spp. and *Mimosa* spp.) and similar climate conditions. *Peniophora albobadia* and *P. rimosus* were found in both types of scrubland. These species are characterized by being more common to the

tropics, to warm and arid zones, although they are almost cosmopolitan (Boidin, 1994; Ryvarden and Gilbertson, 1994; Bernicchia, 2005). The only species that was not common to both types of scrubland (*Phanerochaete cacaina* (Bourdot and Galzin) Burds. and Gilb.) grew on *Ipomoea murucoides*, which is one of the woody plant species that differentiates between the 2 types. Nevertheless, this species does not seem to be exclusive in this plant community, since it has been reported on *Pinus* in Europe and the USA (Burdsall, 1985; Eriksson et al., 1978). Finally, the fungal composition of deciduous tropical forest proved to be the most dissimilar of all the plant communities. This plant community is dominated by woody species that do not occur anywhere else in Aguascalientes (*Manihot* sp., *Ceiba* sp., *Amphipterygium adstringens*, among others), which could explain the dissimilarities in fungal composition. However, this result must be taken with caution since the majority of the species identified were cosmopolitan, although some tropical species also appeared (*Subulicystidium perlongisporum* Boidin and Gilles). Further investigations are needed to determine if this trend is maintained throughout deciduous tropical forest.

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Appendix. List of localities sampled with their elevation and dominant plant community.

Locality	*Locality code*	*UTM*	*Elevation (m)*	*Plant community*	*Sampled dominant species*
Cerro del Muerto	1,1	766499/2422664	1977	Disturbed oak forest	*Quercus resinosa, Q. eduardii*
Cerro del Muerto	1,2	766514/2421715	2199	Disturbed oak forest	*Quercus potosina, Q. resinosa, Q. eduardii, Acacia* sp.
Presa Los Arquitos	2,1	769510/2427002	1836	Subtropical scrubland	*Prosopis laevigata, Ipomoea murucoides, Acacia farnesiana, Opuntia* sp., *Yucca* sp.
Tapias viejas	3,1	753462/2413652	1917	Arid scrubland	*Acacia farnesiana, Forestiera philyreoides, Opuntia* sp.
El Ocote	4,1	755765/2411608	1923	Arid scrubland	*Quercus resinosa, Acacia farnesiana, Opuntia* sp.
El Ocote	4,2	755761/2411539	1931	Disturbed oak forest	*Quercus resinosa, Quercus eduardii, Opuntia* sp.
Palo Alto	5,1	739895/2439347	1944	Subtropical scrubland	*Prosopis laevigata, Ipomoea murucoides, Acacia farnesiana, Opuntia* sp., *Yucca* sp.
El Terrero de los López	6,1	740850/2437169	1850	Subtropical scrubland	*Prosopis laevigata, Ipomoea murucoides, Acacia farnesiana, Opuntia* sp., *Yucca* sp.
Milpillas	7,1	751800/2430669	2162	Disturbed oak forest	*Quercus potosina, Q. resinosa, Q. eduardii, Arctostaphylos pungens*
Gracias a Dios	8,1	757833/2428686	2031	Disturbed oak forest	*Quercus potosina, Q. resinosa, Q. eduardii, Opuntia* sp.
Rancho Peña Azul	9,1	758317/2433580	2359	Oak forest	*Quercus potosina, Q. resinosa, Q. eduardii, Opuntia* sp.
Rancho Peña Azul	9,2	758496/2433329	2433	Pine-oak forest	*Quercus eduardii, Q. potosina, Q. obtusata, Pinus* sp.
Cerro de la Calavera	10,1	756297/2432046	2495	Mixed forest	*Quercus obtusata, Arbutus arizonica, Pinus teocote*
Cerro del Colorín	11,1	756851/2432010	2448	Disturbed pine-oak forest	*Quercus potosina, Q. eduardii, Arctostaphylos pungens*
Cerro del Colorín (Cima)	11,2	759473/2433608	2544	Pine-oak forest	*Quercus obtusata, Q. eduardii, Q. cocolobifolia, Q. aristata, Pinus teocote, Juniperus flaccida, Arbutus teselata*

Presa de los Serna	12,1	725586/2412223	1568	Subtropical scrubland	*Prosopis laevigata, Ipomoea murucoides, Acacia farnesiana, Opuntia* sp.
Presa de los Serna	12,2	723003/2414662	1816	Deciduous tropical forest	*Myrtillocactus geometrizans, Ceiba* sp., *Manihot* sp. *Bursera* sp.
Sierra del Laurel (Los Alisos)	13,1	737232/2404862	2246	Oak forest	*Quercus potosina, Q. eduardii, Arctostaphylos pungens*
Sierra del Laurel	13,2	735875/2403385	2310	Oak forest	*Quercus potosina, Q. eduardii, Arctostaphylos pungens*
Serranía Juan Grande	14,1	200007/2432709	2078	Arid scrubland	*Quercus grisea, Acacia* sp., *Yucca* sp.
Sierra Fría (Tortugas)	15,1	762981/2460352	2118	Disturbed oak forest	*Quercus resinosa*
Sierra Fría	15,2	755063/2461302	2379	Juniperus forest	*Juniperus deppeana, J. flaccida, Quercus laeta, Q. grisea, Q. potosina, Arctostaphylos pungens*
Sierra Fría	15,3	752212/2461444	2505	Juniperus-oak forest	*Quercus potosina, Juniperus deppeana, Arctostaphylos pungens*
Sierra Fría (ladera Cerro de la Ardilla)	15,4	748398/2465725	2724	Mixed forest	*Juniperus deppeana, Quercus obtusata, Q. rugosa, Q. sideroxila, Arctostaphylos pungens*
Sierra Fría (Cerro de la Ardilla)	15,5	748635/2465573	2753	Pine-oak forest	*Pinus duranguensis, P. teocote, P. lumholtzii, Quercus resinosa, Q. potosina, Q. rugosa*
Sierra Fría (Cañada)	15,6	750404/2458092	2294	Oak forest	*Quercus grisea*
Sierra Fría (Barranca)	15,7	750119/2457850	2328	Mixed forest	*Quercus eduardii, Q. rugosa, Q. obtusata, Pinus leiophyla, P. teocote, P. chihuahuensis*