DE GRUYTER Botanica Marina 2023; 66(5): 471–490

Research Article

Julio Olguin, Patricia Velez*, Vivianne Solís-Weiss, Alejandra Barrios, Allison K. Walker, Guadalupe Ponce-Vélez, María C. González, Mario Figueroa and Alfonso Botello

An overview of fungal taxonomic, functional, and genetic diversity in coastal and oceanic biomes in megadiverse Mexico

https://doi.org/10.1515/bot-2023-0031
Received April 17, 2023; accepted August 4, 2023;
published online September 4, 2023

Abstract: A comprehensive literature review of mycodiversity in sandy beaches and oceanic environments in Mexico is presented through the analysis of published works from 1949 to early 2023. In addition, four unexplored sandy beaches in the Pacific Ocean and Gulf of California were sampled in order to fill knowledge gaps in terms of sampling biases. Marine fungi of Mexico were reported from water column, sediment, and debris samples collected in sandy beaches, open ocean, deep-sea plains, hydrothermal vents, and oxygen minimum zones in the Gulf of Mexico, the Pacific Ocean, the Gulf of California, and the Caribbean Sea. The taxonomic, functional, and genetic diversity, as well as distribution patterns and potential use of marine fungal genetic resources are discussed. A list of 126 species in 83 genera, 40 families, 25 orders, 12 classes, three phyla and one subphylum (excluding non-cultured taxa) of marine fungi is documented from Mexico. Lastly, we identified areas that would benefit from additional research, including the exploration of further deep-sea biomes in the Pacific Ocean, and coastal areas covering ecoregions in the states of Sonora, Sinaloa, Nayarit, Michoacán, and Oaxaca.

Keywords: Ascomycota; fungal biodiversity; Halosphaeriaceae; marine biodiversity; marine mycobiota

1 Introduction

Marine fungi are delimited as an ecological, rather than a taxonomic group of chemoorganoheterotrophs, comprising obligate marine (those that grow and sporulate exclusively in a marine or estuarine habitat) and facultative taxa (those from freshwater or terrestrial milieus that are able to grow and possibly also to sporulate in the marine environment) (Kohlmeyer and Kohlmeyer 1979). This assemblage of species includes any fungus that is repeatedly recovered from a marine habitat because: (1) it can grow and/or sporulate (on substrata) in marine environments; (2) it forms symbiotic relationships with marine organisms; or (3) it is adapted and has evolved (or be metabolically active) in the marine environment (Pang et al. 2016). Marine fungi act at many trophic levels (Gladfelter et al. 2019; Hyde et al. 2000; Salcedo et al. 2023), occurring as saprobes, and parasites of algae (Raghukumar 1986), diatoms (Gutiérrez et al. 2016) and marine animals (Hyde et al. 1998; Pang et al. 2021). In addition, numerous symbiotic relationships between marine fungi and other marine biota have been reported including with algae (Kohlmeyer and Kohlmeyer 1979; Raghukumar et al. 2010), corals (Amend et al. 2012), *Armeria maritima* and other halophytic plants (Mason 1928), and marine lichens (Pérez-Ortega et al. 2016).

***Corresponding author: Patricia Velez**, Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México, Coyoacán, Mexico City, 04510, Mexico, E-mail: pvelez@ib.unam.mx. https://orcid.org/0000-0002-4449-8977
Julio Olguin, Posgrado en Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Coyoacán, Mexico City, 04510, Mexico; and Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México, Coyoacán, Mexico City, 04510, Mexico
Vivianne Solís-Weiss, Unidad Académica de Sistemas Arrecifales, Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de Mexico, Puerto Morelos, 77580, Mexico
Alejandra Barrios, Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México, Coyoacán, Mexico City, 04510, Mexico; and Posgrado en Ciencias Biológicas, Universidad Nacional Autónoma de México, Coyoacán, Mexico City, 04510, Mexico
Allison K. Walker, Department of Biology, Acadia University, 33 Westwood Avenue, Wolfville, Nova Scotia, B4P 2R6, Canada. https://orcid.org/0000-0002-5061-361X
Guadalupe Ponce-Vélez and Alfonso Botello, Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Coyoacán, Mexico City, 04510, Mexico
María C. González, Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México, Coyoacán, Mexico City, 04510, Mexico
Mario Figueroa, Facultad de Química, Universidad Nacional Autónoma de México, Coyoacán, Mexico City, 04510, Mexico

With more than 10,000 estimated species of marine fungi worldwide, only 1857 species have been described, representing merely ~19 % (http://www.marinefungi.org) (Jones et al. 2019). Most of these species are known for their worldwide distribution, yet certain taxa may be restricted to biogeographic groups *sensu* Hughes (1974, 1986): (1) Arctic-Antarctic or cold waters, (2) temperate, (3) sub-tropical, (4) tropical, and (5) cosmopolitan (Jones et al. 2022). Although marine fungi in tropical and temperate regions have been extensively studied (Jones and Pang 2012), diversity in tropical–temperate transitional regions remains to be fully explored.

Located in one such tropical–temperate transition region, Mexico is ranked within the top 17 megadiverse countries that harbor much of the Earth's biodiversity (CONABIO 2019; Mittermeier et al. 1999). Due to their environmental heterogeneity, Mexican marine biomes harbor highly productive regions of great biological importance that represent an ideal model to study marine fungal diversity on the tropical–temperate transition. Nonetheless, marine mycology can still be considered as an incipient discipline in this country (Pang et al. 2023).

Since the publication of the first obligate arenicolous species from a German beach in 1922 (*Corollospora maritima*) and the erection of the genus *Corollospora* (Werdermann 1922), the inventory of marine mycobiota in sandy beaches has progressed worldwide (revised in Velez et al. 2022b). In this regard, pioneer investigations across the globe laid the foundations for the development of marine mycology in Mexico (e.g., Höhnk 1955; Koch 1974; Kohlmeyer 1966, 1967, 1968, 1976, 1981, 1984; Kohlmeyer and Kohlmeyer 1971, 1977; Kohlmeyer and Volkmann-Kohlmeyer 1987a,b,c, 1991). The first fungus reported from the Mexican coastline (*Pontogeneia codiicola*) was collected in 1949 on the green algae *Codium simulans* on a rocky shore of the Guadalupe Island, Baja California (Kohlmeyer and Kohlmeyer 1979). Successive reports by Meyers (1957) documented *Antennospora quadricornuta* (originally *Antennospora caribbea*) in the intertidal zone of the Caribbean Sea. In the early 1990s sandy beaches emerged as the most extensively explored marine ecosystem for fungi in Mexico (González 2009; González and Herrera 1993, 1995, 2010; González et al. 1998, 2000, 2001, 2010; Velez et al. 2013, 2015a,b, 2016a,b, 2021). This trend might be attributed to two major phenomena: (1) Mexican sandy beaches developed as top-ranked tourist destinations during the late 1960s (e.g., the colonial port city of Acapulco on the Pacific and the border city of Tijuana) and in the 1980s (e.g., Caribbean beaches, and several destinations in the Pacific including Los Cabos, Ixtapa, and Huatulco) (Faber and Gaubert 2019), and (2) these systems represent priority areas for research in biodiversity, since they face numerous anthropogenic stressors that jeopardize their sustainability.

The first marine fungus to be documented from a Mexican ocean was by Kohlmeyer (1984) who reported *Lulworthia kniepii* from the red alga *Paragoniolithon solubile* (now *Neogoniolithon fosliei*) in the Gulf of California, perhaps representing the first record (considering distribution of the host). However, it was not until early 2000s that the formal exploration of oceanic biomes was developed through investigation of deep-sea plains (González-Martínez et al. 2017, 2019; Vargas-Gastélum et al. 2019; Velez et al. 2020), hydrothermal vents (Hernández 2019; Velez et al. 2022a), and oxygen minimum zones (Posadas 2023).

In 2001, González et al. (2001) published the first checklist of Mexican marine fungi, reporting 62 species, mostly collected from beaches between 1949 and 2001. Subsequently, 50 further records of fungal taxa from marine habitats were listed for this country (Portillo-López and González-Martínez 2021). However, relevant data remained overlooked including: (1) updated figures on taxonomic (species-level), genetic and functional diversity; (2) reports from hydrothermal vents, and oxygen minimum zones; and (3) documentation of genetic lineages of the common arenicolous marine species, *C. maritima sensu lato*. Thus, the objective of this work is to present a thorough review and analysis of scientific literature reporting fungal diversity in Mexican marine environments from 1949 to 2023. In addition, records for unexplored sandy beaches in the Pacific Ocean and Gulf of California are provided to fill knowledge gaps in terms of sampling biases. We revised information on taxonomic, functional, and genetic diversity, as well as distribution patterns and the potential application of marine fungal genetic resources for bioprospecting, as bioindicators and in hydrocarbon bioremediation.

We provide a list of 126 species of marine fungi, including three genetic lineages of *C. maritima sensu lato*, occurring in a wide range of coastal and oceanic ecosystems (e.g., sandy beaches, wetlands, seagrass and algal beds, deep-sea plains, oceanic oxygen minimum zones, and hydrothermal vents; Table 1). This number excludes non-cultured taxa, and these species can be referred to 83 genera, 40 families, 25 orders, 12 classes, three phyla and one subphylum. The taxa contained in this checklist correspond to reports from the Gulf of Mexico, Pacific Ocean, Gulf of California, and Caribbean Sea.

2 Materials and methods

The bibliographic search was conducted on main scientific databases including PubMed (591 records), Scopus (53 records), ScienceDirect (4760 records), and Scielo (three records). Reference works written prior

Table 1: List of marine fungi reported in Mexico from 1949 to 2023, presenting information on their distribution, ecology, and putative functional guilds.

Phylum	Class	Order	Family	Species	Localities	Reports
Ascomycota	Sordariomycetes	Hypocreales	*Incertae sedis*	*Acremonium* sp. [FA, SA a]	Ver, GM Jal, Nay, PO	González and Herrera (1993)
Ascomycota	Sordariomycetes	Hypocreales	*Incertae sedis*	*Acremonium murorum.* (Corda) W. Gams 1971 [FA, SA a]	Gue, PO	González et al. (2000)
Ascomycota	Sordariomycetes	Hypocreales	*Incertae sedis*	*Acremonium rutilum.* W. Gams 1971 [FA, SA a]	Ver, GM	González et al. (1998)
Ascomycota	Sordariomycetes	Hypocreales	Stachybotryaceae	*Albifimbria verrucaria* (Alb. *et* Schwein.) L. Lombard *et* Crous. 2016 [FA, SA a]	Jal, PO Ver, GM	González and Herrera (1993), González et al. (1998)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Alternaria* sp. [FA, SA, PA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Alternaria* sp. [FA, SA, PA a]	Ver, Cam, GM Nay, PO	Romero-Hernández et al. (2021)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Alternaria* sp. [FA, SA, PA a]	Bac, GC	This study
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Alternaria alternata* (Fr.) Keissl. 1912 [FA, SA, PA a]	Col, PO	González et al. (1998)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Alternaria citri* Ellis *et* N. Pierce 1902 [FA, SA, PA a]	Ver, GM	González et al. (1998)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Alternaria longipes* (Ellis *et* Everh.) E.W. Mason. 1928 [FA, SA, PA a]	Qro, CS	González et al. (1998)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Antennospora quadricornuta* (Cribb *et* J.W. Cribb) T.W. Johnson. 1958 [MA, SA a]	Oax, Jal, PO Bcs, GC Qro, CS	Kohlmeyer (1968, 1984), González and Herrera (1995)
Ascomycota	Eurotiomycetes	Onygenales	Gymnoascaceae	*Arachniotus dankaliensis* (Castell.) J.F.H. Beyma 1942 [FA, SA a]	Ver, GM Gue, PO	González et al. (2000)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Arenariomyces majusculus* Kohlm. *et* Volkm.-Kohlm. 1989 [MA, SA a]	Ver, GM	Velez et al. (2013)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Arenariomyces parvulus* Jørg. Koch 1986 [MA, SA a]	Qro, CS Ver, GM	González et al. (1998, 2001), Velez et al. (2013, 2015a)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Arenariomyces triseptatus* Kohlm. 1984 [MA, SA a]	Qro, Yuc, CS Cam, GM	Kohlmeyer (1984), Kohlmeyer and Kohlmeyer (1971), Velez et al. (2013, 2015a)
Ascomycota	Eurotiomycetes	Onygenales	Arthrodermataceae	*Arthroderma curreyi* Berk. 1860 [FA, SA a]	Qro, CS	González et al. (2000)
Ascomycota	Dothideomycetes	*Incertae sedis*	Eremomycetaceae	*Arthrographis kalrae* (R.P. Tewari *et* Macph.) Sigler *et* J.W. Carmich. 1976 [FA PA a]	Bac, GC	Velez et al. (2021)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Ascosacculus heteroguttulatus* (S.W. Wong, K.D. Hyde *et* E.B.G. Jones) J. Campb., J.L. Anderson *et* Shearer 2003 [MA, SA a]	Tab, GM	Velez et al. (2015b)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus* sp. [FA, SA a]	Yuc, CS	Fajardo-Hernández et al. (2022)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus* sp. [FA, SA a]	Gue, PO	Aparicio-Cuevas et al. (2019)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus* sp. [FA, SA a]	Gue, PO	Aparicio-Cuevas et al. (2017)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus* sp. [FA, SA a]	Bcs, GC	González-Martínez et al. (2017)

Table 1: (continued)

Phylum	Class	Order	Family	Species	Localities	Reports
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus* sp. [FA, SA a]	Bcs, GC	This study
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus* sp. [FA, SA a c]	Ver, GM Chi, Nay, PO	Valderrama et al. (2016)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus amstelodami* (L. Mangin) Thom *et* Church 1926 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus auricomus* (Guég.) Saito. 1939 [FA, SA a]	Ver, GM	González et al. (2000)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus chevalieri* (L. Mangin) Thom *et* Church 1926 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus costiformis* H.Z. Kong *et* Z.T. Qi 1995 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus cristatus* Raper *et* Fennell 1965 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus fumigatus* Fresen. 1863 [FA, SA a]	Ver, GM Gue, PO	González et al. (2000)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus flavo-furcatus* Bat. *et* H. Maia. 1955 [FA, SA a]	Gue, PO	González et al. (2000)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus flavus* link. 1809 [FA, SA a]	Jal, Col, PO Ver, GM Qro, CS Bac, GC	González and Herrera (1993), González et al. (1998)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus loretoensis* S. González-Martínez *et* A. Portillo-López. 2019 [MA, SA b]	GC	González-Martínez et al. (2019)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus nidulans* (Eidam) G. Winter 1884 [FA, SA a]	Ver, GM Col, PO Qro, CS	González and Herrera (1993), González et al. (1998)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus niger* Tiegh. 1867 [FA, SA a]	Ver, GM Qro, CS Jal, Col, Nay PO	González and Herrera (1993), González et al. (1998)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus pulverulentus* (McAlpine) Thom 1926 [FA, SA a]	Ver, GM	González et al. (1998)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus recurvatus* Raper *et* Fennell 1965. [FA, SA a]	Gue, PO	González et al. (2000)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus repens* (Corda) Sacc. 1882 [FA, SA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus ruber* (Jos. König, Spieck. *et* W. Bremer) Thom *et* Church 1926 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus salinarum* (Greiner, Peršoh, Weig *et* Rambold) Zalar *et* Greiner 2017 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus tamarii* Kita 1913 [FA, SA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus terreus* Thom 1918 [FA, SA a]	Bac, GC Ver, GM Qro, CS Col, Gue, Nay, PO	González et al. (1998, 2000), Velez et al. (2021)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus tonophilus* Ohtsuki. 1962 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Aspergillus violaceus* Fennell *et* Raper. 1955 [FA, SA a]	Col, PO	González et al. (1998)
Ascomycota	Dothideomycetes	Dothideales	Saccotheciaceae	*Aureobasidium pullulans* (De Bary *et* Löwenthal) G. Arnaud. 1917 [FA, PA a]	Qro, CS Col, Nay, PO Bac, GC	González et al. (1998)

Table 1: (continued)

Phylum	Class	Order	Family	Species	Localities	Reports
Ascomycota	Dothideomycetes	Pleosporales	Camarosporiaceae	*Camarosporium roumeguerei* Sacc. 1880 [FA, PA a]	Son, PO	Kohlmeyer and Kohlmeyer (1979)
Ascomycota	Saccharomycetes	Saccharomycetales	*Incertae sedis*	*Candida* sp. [FA, SA c]	Tam, GM	Valderrama et al. (2016)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Ceriosporopsis capillacea* Kohlm. 1981 [MA, SA a]	Tab, GM	Velez et al. (2015b)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Ceriosporopsis halima* Linder 1944 [MA, SA a]	Tab, Ver, GM	González et al. (2001), Velez et al. (2013, 2015b)
Ascomycota	Sordariomycetes	Sordariales	Chaetomiaceae	*Chaetomium* sp. [FA, SA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Sordariomycetes	Sordariales	Chaetomiaceae	*Chaetomium globosum* Kunze 1817 [FA, SA a]	Col, PO	González et al. (1998)
Ascomycota	Eurotiomycetes	Onygenales	Onygenaceae	*Chrysosporium tropicum* J.W. Carmich. 1962 [FA, SA a]	Qro, CS	González et al. (2000)
Ascomycota	Sordariomycetes	Diaporthales	Cryphonectriaceae	*Chrysoporthe* sp. [FA, SA c]	Chi, PO	Valderrama et al. (2016)
Chytridiomycota	Chytridiomycetes	Chytridiales	Chytriomycetaceae	*Chytriomyces* sp. [FA, SA c]	Tam, GM	Valderrama et al. (2016)
Mucoromycota	Mucoromycetes	Mucorales	Syncephalastraceae	*Circinella mucoroides* Saito 1907 [FA, SA a]	Tab, GM	González and Herrera (2010)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Cirrenalia pseudomacrocephala* Kohlm. 1968 [MA, SA a]	Ver, GM	Kohlmeyer (1968)
Ascomycota	Dothideomycetes	Capnodiales	Cladosporiaceae	*Cladosporium* sp. [FA, SA b]	GM PO	Velez et al. (2020)
Ascomycota	Dothideomycetes	Capnodiales	Cladosporiaceae	*Cladosporium* sp. [FA, SA b]	CS	Fajardo-Hernández et al. (2022)
Ascomycota	Dothideomycetes	Capnodiales	Cladosporiaceae	*Cladosporium cladosporioides* (Fresen.) G.A. de Vries 1952 [FA, SA a]	Qro, CS Ver, GM Jal, Col, Nay, PO	González and Herrera (1993), González et al. (1998)
Ascomycota	Dothideomycetes	Capnodiales	Cladosporiaceae	*Cladosporium cucumerinum* Ellis *et* Arthur 1889 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Dothideomycetes	Capnodiales	Cladosporiaceae	*Cladosporium halotolerans* Zalar, de Hoog *et* Gunde-Cim. 2007 [FA, SA b]	GM	Romero-Hernández et al. (2021)
Ascomycota	Dothideomycetes	Capnodiales	Cladosporiaceae	*Cladosporium herbarum* (Pers.) link. 1815 [FA, SA a b]	Qro, CS Col, PO Ver, GM GC	González et al. (1998), González-Martínez et al. (2017)
Ascomycota	Dothideomycetes	Capnodiales	Cladosporiaceae	*Cladosporium ramotenellum* K. Schub., Zalar, Crous *et* U. Braun 2007 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Dothideomycetes	Capnodiales	Cladosporiaceae	*Cladosporium sphaerospermum* Penz. 1882 [FA, SA a]	Jal, Col, PO Ver, GM Qro, CS	González and Herrera (1993), González et al. (1998)
Ascomycota	Saccharomycetes	Saccharomycetales	Metschnikowiaceae	*Clavispora lusitaniae* Rodr. Mir. 1979 [FA, SA a]	Qro, CS	González et al. (1998)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Cochliobolus geniculatus* R.R. Nelson 1964 [FA, SA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora angusta* Nakagiri *et* Tokura 1987 [MA, SA a]	Ver, GM	González et al. (1998)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora gracilis* Nakagiri *et* Tokura 1987 [MA, SA a]	Qro, CS Tab, Ver, GM Bac, GC	González et al. (1998), Velez et al. (2015a,b, 2020, 2021)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora intermedia* I. Schmidt 1970 [MA, SA a]	Jal, PO	González and Herrera (1993)

Table 1: (continued)

Phylum	Class	Order	Family	Species	Localities	Reports
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora maritima sensu lato* Werderm. 1922 [MA, SA a]	Bac, Bcs, GC Col, Jal, Oax, PO Ver, Tab, Yuc, GM Qro, CS	Kohlmeyer (1968, 1984), Kohlmeyer and Kohlmeyer (1971), González and Herrera (1993), González et al. (1998, 2001, 2010), Velez et al. (2015a,b, 2021)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora maritima* lineage 1 [MA, SA a]	Son, PO Yuc, CS Tam, Cam, GM Bac, GC	Velez et al. (2016)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora maritima* lineage 4 [MA, SA a]	Qro, CS	Velez et al. (2016)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora maritima* lineage 5 [MA, SA a]	Ver, Tab, Tam, GM Jal, Gue, PO	Velez et al. (2016)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora pseudopulchella* Nakagiri *et* Tokura 1987 [MA, SA a]	Tab, GM Qro, CS	González et al. (2001), Velez et al. (2015b)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora pulchella* Kohlm., I. Schmidt *et* N.B. Nair 1967 [MA, SA a]	Tab, Cam, GM Qro, Yuc, CS Col, Oax, PO	Kohlmeyer (1968, 1969, 1984), Hyde (1992), González et al. (1998), Velez et al. (2013, 2015b)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora ramulosa* (Meyers *et* Kohlm.) E.B.G. Jones *et* Abdel-Wahab 2016 [MA, SA a]	Ver, Tab, GM Yuc, Qro, CS	Kohlmeyer (1984), Kohlmeyer and Kohlmeyer (1971), González et al. (1998), Velez et al. (2013)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora trifurcata* (Höhnk) Kohlm. 1962 [MA, SA a]	Tab, Cam, GM Oax, PO Qro, Yuc, CS	Kohlmeyer (1968, 1984), Kohlmeyer and Kohlmeyer (1971), Velez et al. (2013, 2015b)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora* sp. [MA, SA a]	Tab, GM	Velez et al. (2015b)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Corollospora* sp. [MA, SA a]	Bac, GC	This study
Mucoromycota	Mucoromycetes	Mucorales	Cunninghamellaceae	*Cunninghamella echinulata* (Thaxt.) Thaxt. ex Blakeslee 1905 [FA, SA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Curvularia intermedia* Boedijn 1933 [FA SA a]	Ver, GM	González et al. (1998)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Curvularia eragrostidis* (Henn.) J.A. Mey. 1959 [FA, SA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Curvularia lunata* (Wakker) Boedijn 1933 [FA, SA a]	Jal, Col, PO	González and Herrera (1993), González et al. (1998)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Curvularia pallescens* Boedijn 1933 [FA, SA a]	Ver, GM	González et al. (1998)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Curvularia senegalensis* (Speg.) Subram. 1956 [FA, SA a]	Col, PO	González et al. (1998)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Curvularia tuberculata* B.L. Jain 1962 [FA, SA a]	Ver, GM	González et al. (1998)
Ascomycota	Saccharomycetes	Saccharomycetales	Dipodascaceae	*Dipodascus geotrichum* (E.E. Butler *et* L.J. Petersen) Arx 1977 [FA, SA a]	Jal, PO Qro, CS	González and Herrera (1993), González et al. (2000)

Table 1: (continued)

Phylum	Class	Order	Family	Species	Localities	Reports
Ascomycota	Dothideomycetes	Pleosporales	Didymellaceae	*Didymellaceae* sp. [FA, SA a]	Bac, GC	This study
Ascomycota	Dothideomycetes	Pleosporales	Didymellaceae	*Epicoccum nigrum* link 1815 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Eurotiomycetes	Chaetothyriales	Herpotrichiellaceae	*Exophiala* sp. [FA, SA a]	Bac, GC	Velez et al. (2021)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Exserohilum rostratum* (Drechsler) K.J. Leonard *et* Suggs 1974 [FA, SA a]	Ver, GM Jal, PO	González and Herrera (1993), González et al. (1998)
Ascomycota	Sordariomycetes	Hypocreales	Nectriaceae	*Fusarium fujikuroi* Nirenberg 1976 [FA, SA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Sordariomycetes	Hypocreales	Nectriaceae	*Fusarium incarnatum* (Desm.) Sacc. 1886 [FA, SA a]	Jal, Col PO, Ver, GM Qro, CS	González and Herrera (1993), González et al. (1998, 2000)
Ascomycota	Sordariomycetes	Hypocreales	Nectriaceae	*Fusarium neocosmosporiellum* O'Donnell *et* Geiser 2013 [FA, SA a]	Col, PO	González et al. (1998)
Ascomycota	Sordariomycetes	Hypocreales	Nectriaceae	*Fusarium oxysporum* Schltdl. 1824 [FA, SA a]	Ver, GM Jal, PO	González and Herrera (1993)
Ascomycota	Sordariomycetes	Hypocreales	Nectriaceae	*Fusarium solani* (Mart.) Sacc. 1881 [FA, SA a]	Jal, Col. PO Ver, GM Qro, CS Bac, GC	González and Herrera (1993), González et al. (1998, 2000), Velez et al. (2021)
Ascomycota	*Incertae sedis*	*Incertae sedis*	*Incertae sedis*	*Gilmaniella humicola* G.L. Barron 1964. [FA, SA a]	Ver, GM	González et al. (1998)
Ascomycota	Sordariomycetes	Microascales	Microascaceae	*Graphium penicillioides* Corda 1837 [FA, SA a]	Col, PO	González et al. (1998)
Ascomycota	Eurotiomycetes	Onygenales	Gymnoascaceae	*Gymnascella hyalinospora* (Kuehn, G.F. Orr *et* G.R. Ghosh) Currah 1985 [FA, SA a]	Gue, PO	Aparicio-Cuevas et al. (2019)
Ascomycota	Eurotiomycetes	Onygenales	Gymnoascaceae	*Gymnoascus* sp. [FA, SA a]	Ver, GM Gue, PO	González et al. (2000)
Ascomycota	Eurotiomycetes	Onygenales	Gymnoascaceae	*Gymnoascus hyalinosporus* Kuehn, G.F. Orr *et* G.R. Ghosh) M. Solé, Cano *et* Guarro 2002 [FA, SA a]	Gue, PO	Aparicio-Cuevas et al. (2019)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Haiyanga salina* (Meyers) K.L. Pang *et* E.B.G. Jones 2008 [MA, SA a]	Oax, Chi, PO Qro, CS Cam, Ver, GM	Kohlmeyer (1968, 1969, 1984), González et al. (1998), Velez et al. (2013)
Ascomycota	Leotiomycetes	Helotiales	Tricladiaceae	*Halenospora varia* (Anastasiou) E.B.G. Jones 2009 [FA, SA a]	Tab, Cam, GM	González and Herrera (1995), Velez et al. (2015b)
Ascomycota	Sordariomycetes	Sordariales	Chaetomiaceae	*Humicola alopallonella* Meyers *et* R.T. Moore 1960 [MA, SA a]	Qro, CS Jal, PO	Kohlmeyer (1984), González and Herrera (1995)
Ascomycota	Sordariomycetes	Lulworthiales	Halosphaeriaceae	*Hydea pygmea* (Kohlm.) K.L. Pang *et* E.B.G. Jones 2010 [MA, SA a]	Chi, PO	Kohlmeyer (1968)
Ascomycota	Dothideomycetes	Botryosphaeriales	Botryosphaeriaceae	*Lasiodiplodia theobromae* (Pat.) Griffon *et* Maubl. 1909 [FA, SA a]	Jal, Col, PO	González and Herrera (1993), González et al. (1998)
Ascomycota	Sordariomycetes	Sordariales	Lasiosphaeriaceae	*Lasiosphaeria* sp. [FA, SA a]	Bac, GC	Velez et al. (2021)
Ascomycota	Dothideomycetes	Pleosporales	Phaeosphaeriaceae	*Leptosphaerella* sp. [FA, SA a]	Mer, Tab, GM Yuc, CS	Velez et al. (2013)

Table 1: (continued)

Phylum	Class	Order	Family	Species	Localities	Reports
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Lignincola laevis* Höhnk. 1955 [MA, SA a]	Col, PO Ver, Cam, GM	Velez et al. (2013)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Lignincola tropica* Kohlm. 1984 [MA, SA a]	Qro, CS	Kohlmeyer (1984)
Ascomycota	Sordariomycetes	Lulworthiales	Lulworthiaceae	*Lindra crassa* Kohlm. *et* Volkm.-Kohlm. 1991 [MA, SA a]	Mer, Ver, GM Qro, Yuc, CS	Kohlmeyer (1984), Velez et al. (2013)
Ascomycota	Sordariomycetes	Lulworthiales	Lulworthiaceae	*Lindra thalassiae* Orpurt, Meyers, Boral *et* Simms 1964 [MA, SA a]	Cam, Ver, GM Qro, Yuc, CS Col, PO Bcs, GC	Kohlmeyer (1984), Kohlmeyer and Kohlmeyer (1971), González et al. (1998), Velez et al. (2013, 2015a)
Ascomycota	Dothideomycetes	Lineolatales	Lineolataceae	*Lineolata rhizophorae* Kohlm. *et* E. Kohlm. 1990 [MA, SA a]	Bcs, GC Ver, GM	Kohlmeyer (1984), Velez et al. (2013)
Ascomycota	Sordariomycetes	Lulworthiales	Lulworthiaceae	*Lulworthia* sp. [MA, SA a]	Jal, PO	González and Herrera (1995)
Ascomycota	Sordariomycetes	Lulworthiales	Lulworthiaceae	*Lulworthia* sp. [MA, SA a]	Ver, GM Oax PO Qro, CS	Kohlmeyer (1968)
Ascomycota	Sordariomycetes	Lulworthiales	Lulworthiaceae	*Lulworthia* sp. [MA, SA a]	Tab, Ver, Cam, Yuc, Tam, GM	Velez et al. (2013)
Ascomycota	Sordariomycetes	Lulworthiales	Lulworthiaceae	*Lulworthia* sp. [MA, SA a]	Tab, GM	Velez et al. (2015b)
Ascomycota	Sordariomycetes	Lulworthiales	Halosphaeriaceae	*Matsusporium tropicale* (Kohlm.) E.B.G. Jones *et* K.L. Pang. 2010 [MA, SA a]	Col, PO	González et al. (1998)
Ascomycota	Dothideomycetes	Mycosphaerellales	Niessliaceae	*Melanopsamma balani* (G. Winter) Meyers. 1957 [MA, SA a]	Son, PO	Kohlmeyer and Kohlmeyer (1979)
Ascomycota	Saccharomycetes	Saccharomycetales	Debaryomycetaceae	*Meyerozyma guilliermondii* (Wick.) Kurtzman *et* M. Suzuki. 2010 [FA, SA a]	Bac, GC	Velez et al. (2021)
Ascomycota	Sordariomycetes	Microascales	Microascaceae	*Microascus* sp. [MA, SA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Sordariomycetes	Microascales	Microascaceae	*Microascus brevicaulis* S.P. Abbott 1998 [FA, SA a]	Jal, Col, PO Qro, CS	González and Herrera (1993), González et al. (1998, 2000)
Ascomycota	Sordariomycetes	Microascales	Microascaceae	*Microascus cinereus* Curzi 1931 [MA, SA a]	Gue, PO	González et al. (2000)
Ascomycota	Sordariomycetes	Microascales	Microascaceae	*Microascus manginii* (Loubière) Curzi 1931 [MA, SA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Sordariomycetes	Microascales	Microascaceae	*Microascus melanosporus* (Udagawa) Woudenb. *et* Samson 2017 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Sordariomycetes	Microascales	Microascaceae	*Microascus trigonosporus* C.W. Emmons *et* B.O. Dodge 1931 [FA, PA, SA a]	Jal, PO Ver, GM	González and Herrera (1993), González et al. (1998)
Mucoromycota	Mucoromycetes	Mucorales	Mucoraceae	*Mucor hiemalis* Wehmer. 1903 [MA, SA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Dothideomycetes	Mycosphaerellales	Mycosphaerellaceae	*Mycosphaerella* sp. [FA, SA a]	Ver, GM	Velez et al. (2013)
Ascomycota	Dothideomycetes	Mycosphaerellales	Mycosphaerellaceae	*Mycosphaerella salicorniae* (Auersw.) Lindau 1903 [FA, SA a]	Yuc, CS Bcs, GC	Kohlmeyer (1980, 1984)
Basidiomycota	Agaricomycetes	Agaricales	Niaceae	*Nia* sp. [MA, SA a]	Bac, GC	Velez et al. (2021)
Basidiomycota	Agaricomycetes	Agaricales	Niaceae	*Nia vibrissa* R.T. Moore *et* Meyers 1959 [MA, SA a]	Qro, CS	Kohlmeyer (1984)

Table 1: (continued)

Phylum	Class	Order	Family	Species	Localities	Reports
Ascomycota	Sordariomycetes	*Incertae sedis*	*Incertae sedis*	*Nigrospora oryzae* (Berk. *et* Broome) Petch 1924 [FA, SA a]	Jal, Col, PO Ver, GM Qro, CS	González and Herrera (1993), González et al. (1998)
Ascomycota	Sordariomycetes	Sordariales	Sordariaceae	*Neurospora sitophila* Shear *et* B.O. Dodge 1927 [FA, SA a]	Col, PO	González et al. (1998)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Okeanomyces cucullatus* (Kohlm.) K.L. Pang *et* E.B.G. Jones 2004 [MA, SA a]	Oax, PO	Kohlmeyer (1969)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Paecilomyces* sp. [FA, SA c]	Tam, GM Nay, Chi, PO	Valderrama et al. (2016)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Paradendryphiella arenariae* (Nicot) Woudenb. *et* Crous 2013 [MA, SA a]	Col, PO	González et al. (1998)
Ascomycota	Sordariomycetes	Hypocreales	Stachybotryaceae	*Paramyrothecium roridum* (Tode) L. Lombard *et* Crous 2016 [FA, SA a]	Col, PO	González et al. (1998)
Ascomycota	Sordariomycetes	Hypocreales	Cordycipitaceae	*Parengyodontium album* (Limber) C.C. Tsang, J.F.W. Chan, W.M. Pong, J.H.K. Chen, A.H.Y. Ngan, M. Cheung, C.K.C. Lai, D.N.C. Tsang, S.K.P. Lau *et* P.C.Y. Woo 2016 [FA SA a]	Bac, GC	Velez et al. (2021)
Ascomycota	Sordariomycetes	Hypocreales	Cordycipitaceae	*Parengyodontium album* (Limber) C.C. Tsang, J.F.W. Chan, W.M. Pong, J.H.K. Chen, A.H.Y. Ngan, M. Cheung, C.K.C. Lai, D.N.C. Tsang, S.K.P. Lau *et* P.C.Y. Woo 2016 [FA SA a]	Bcs, GC	This study
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Penicillium* sp. [FA, SA a]	Ver, GM	Velez et al. (2020)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Penicillium* sp. [FA, SA a]	Bac, GC	Velez et al. (2021)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Penicillium* sp. [FA, SA a]	Ver, GM	Romero-Hernández et al. (2021)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Penicillium brevicompactum* Dierckx 1901 [FA, SA b]	GM	Velez et al. (2020)
Basidiomycota	Agaricomycetes	Russulales	Peniophoraceae	*Peniophora* sp. [FA, SA b]	GC	González-Martínez et al. (2017)
Basidiomycota	Agaricomycetes	Russulales	Peniophoraceae	*Peniophora incarnata* (Pers.) P. Karst. 1889 [FA, SA b]	GC	González-Martínez et al. (2017)
Basidiomycota	Agaricomycetes	Russulales	Peniophoraceae	*Peniophora pini* (Schleich. Ex DC.) Boidin 1956 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Leotiomycetes	Helotiales	Mollisiaceae	*Phialocephala* sp. [FA, SA b]	GM	Velez et al. (2020)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Pleospora* sp. [FA, SA a]	Col, PO	Velez et al. (2021)
Ascomycota	Sordariomycetes	*Incertae sedis*	*Incertae sedis*	*Pontogeneia codiicola* (Dowson) Kohlm. *et* E. Kohlm. 1979 [FA, SA a]	Bac, GC	Dawson (1949)
Ascomycota	Sordariomycetes	*Incertae sedis*	*Incertae sedis*	*Pontogeneia padinae* Kohlm. 1975 [FA, SA a]	Son, PO	Kohlmeyer (1975)
Ascomycota	Sordariomycetes	Microascales	Chaetomiaceae	*Pseudothielavia terricola* (J.C. Gilman *et* E.V. Abbott) X. WeiWang *et* Houbraken 2019 [MA, SA a]	Col, PO	González et al. (1998)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Pyrenophora biseptata* (Sacc. *et* Roum.) Crous. 2013 [FA, SA a]	Jal, PO Qro, CS	González and Herrera (1993), González et al. (1998)

Table 1: (continued)

Phylum	Class	Order	Family	Species	Localities	Reports
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Remispora* sp. [MA, SA a]	Tab, GM	Velez et al. (2015b)
Basidiomycota	Microbotryomycetes	Sporidiobolales	Sporidiobolaceae	*Rhodotorula mucilaginosa* (A. Jörg.) F.C. Harrison 1928 [FA, SA a]	Qro, CS	González et al. (1998)
Choanozoa	Rozellidea	Rozellidea	Rozellidae	*Rozella* sp. [FA, SA c]	Nay, Jal, PO Tam, GM	Valderrama et al. (2016)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Saagaromyces abonnis* (Kohlm.) K.L. Pang *et* E.B.G. Jones 2003 [MA, SA, PA a]	Bcs, GC	Kohlmeyer (1984)
Ascomycota	Saccharomycetes	Saccharomycetales	Saccharomycetaceae	*Saccharomyces* sp. [FA, SA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Sordariomycetes	Lulworthiales	Lulworthiaceae	*Sammeyersia grandispora* (Meyers) S.Y. Guo, E.B.G. Jones *et* K.L. Pang 2017 [MA, SA a]	Qro, CS Tab, Cam, GM Jal, Col, PO Bcs, GC	Kohlmeyer (1984), González and Herrera (1995), Velez et al. (2015a,b)
Ascomycota	Sordariomycetes	Savoryellales	Savoryellaceae	*Savoryella lignicola* E.B.G. Jones *et* R.A. Eaton 1969 [MA, SA a]	Tab, GM Col, PO	Velez et al. (2015b)
Ascomycota	Sordariomycetes	Microascales	Microascaceae	*Scopulariopsis* sp. [FA, SA, a b]	Bac, GC Nay, PO	González-Martínez et al. (2017), Velez et al. (2021)
Ascomycota	Sordariomycetes	Microascales	Microascaceae	*Scopulariopsis brumptii* Salv.-Duval 1935 [FA, SA a b]	Jal, PO Ver, GM GC	González and Herrera (1993), González et al. (2000), González-Martínez et al. (2017)
Ascomycota	Sordariomycetes	Microascales	Microascaceae	*Scopulariopsis sphaerospora* Zach 1934 [FA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Sordariomycetes	Hypocreales	Stachybotryaceae	*Stachybotrys* sp.	Yuc, CS	Fajardo-Hernández et al. (2022)
Ascomycota	Sordariomycetes	Hypocreales	Stachybotryaceae	*Stachybotrys chartarum* (Ehrenb.) S. Hughes 1958 [FA, SA a]	Ver, Cam, GM	González et al. (1998)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Stemphylium* sp. [FA, SA a]	Jal, PO	González and Herrera (1993), Romero-Hernández et al. (2021)
Mucoromycota	Mucoromycetes	Mucorales	Syncephalastraceae	*Syncephalastrum racemosum* Cohn ex J. Schröt. 1886 [FA, SA a]	Jal, PO	González and Herrera (1993)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Talaromyces* sp. [MA, SA b]	GM GC	González-Martínez et al. (2017)
Ascomycota	Eurotiomycetes	Eurotiales	Aspergillaceae	*Talaromyces assiutensis* Samson *et* Abdel-Fattah 1978 [MA, SA b]	GC	González-Martínez et al. (2017)
Ascomycota	Sordariomycetes	Torpedosporales	Torpedosporaceae	*Torpedospora radiata* Meyers 1957 [MA, SA a]	Tab, Ver, Cam, GM Col, PO Yuc, Qro, CS	González et al. (1998), Velez et al. (2015b)
Ascomycota	Sordariomycetes	Hypocreales	Hypocreaceae	*Trichoderma* sp. [FA, SA a]	Ver, GM Jal, PO	González and Herrera (1993)
Ascomycota	Sordariomycetes	Hypocreales	Hypocreaceae	*Trichoderma viride* Pers. 1794 [FA, SA a]	Ver, GM Qro, CS Col, PO	González et al. (1998)
Ascomycota	Sordariomycetes	Microascales	Halosphaeriaceae	*Tubakiella galerita* (Tubaki) Sakay., K.L. Pang *et* E.B.G. Jones 2011 [MA, SA a]	Yuc, GM	Kohlmeyer and Kohlmeyer (1971)

Table 1: (continued)

Phylum	Class	Order	Family	Species	Localities	Reports
Ascomycota	Sordariomycetes	Microascales	Pleuroascaceae	*Venustampulla parva* (A.H.S. Br. *et* G. Sm.) Unter. *et* Réblová 2019 [FA, SA a]	Qro, CS	González et al. (2000)
Ascomycota	Dothideomycetes	Pleosporales	Pleosporaceae	*Verruculina enalia* (Kohlm.) Kohlm. *et* Volkm.-Kohlm. 1990 [FA, SA a]	Ver, GM	Kohlmeyer (1968)
Ascomycota	Sordariomycetes	Microascales	Microascaceae	*Yunnania carbonaria* (F.J. Morton *et* G. Sm.) Woudenb., Houbraken *et* Samson 2017 [FA, SA a]	Gue, PO	González et al. (2000)
Ascomycota	Sordariomycetes	Xylariales	Zygosporiaceae	*Zygosporium masonii* S. Hughes 1951 [FA, SA a]	Jal, Col, PO	González and Herrera (1993), González et al. (1998)

SA, saprotrophic; PA, pathogen; FA, facultative marine species; MA, obligate marine species. The environment is indicated as follows: [a]sandy beach/intertidal zone; [b]deep-sea plain; [c]water column (hypersaline sea). Data from high-throughput amplicon sequencing are not considered. The abbreviations of the states from where the isolates were obtained are listed as: Bac, Baja California; Bcs, Baja California Sur; Cam, Campeche; Chi, Chiapas; Gue, Guerrero; Jal, Jalisco; Nay, Nayarit; Qro, Quintana Roo; Son, Sonora; Tab, Tabasco; Tam, Tamaulipas; Ver, Veracruz; Yuc, Yucatán; the nomenclature denoting littorals is denoted as: PO, Pacific Ocean; GM, Gulf of Mexico; CS, Caribbean Sea; GC, Gulf of California.

to 2001 were examined to retrieve relevant elements on fungal distribution and ecology. Furthermore, we focused on works coming sandy beaches, deep-sea plains, open sea, and hydrothermal vents on morphological, culturable, genetic and metabarcoding diversity studies.

Additionally, in order to fill knowledge gaps in terms of sampling biases across the Baja California Peninsula (Pacific Ocean and Gulf of California), sampling of four sandy beaches (De Los Angeles Bay, Loreto Bay, Santa Rosalia, Beach Alfredo) was conducted in August 2017 following the field sampling procedures described in Velez et al. (2016b). Briefly, washed-up organic detritus covered with moist sand was collected at each site, placed in Ziploc® plastic bags and incubated for eight months under laboratory conditions (23 °C with a 12-h photoperiod) to induce production of fungal reproductive structures. The material was analyzed for mycelia and reproductive structures. Morphological observations were made, and axenic isolates were obtained on potato dextrose agar (PDA; Sigma-Aldrich, St. Louis, MO, USA) supplemented with artificial seawater (salinity 31.4; Fluval Sea, Montreal, Canada). Fungi were identified based on morphology of their reproductive structures using the taxonomic keys of Kohlmeyer and Kohlmeyer (1979) and Kohlmeyer and Volkmann-Kohlmeyer (1991).

In addition, the universal DNA barcode marker for fungi (nuclear ribosomal internal transcribed spacer region, ITS rDNA; Schoch et al. 2012) was sequenced and analyzed as well as the beta-tubulin gene (*benA*). Mycelium was harvested from liquid cultures, and DNA was extracted using the protocol described by Doyle and Doyle (1987). The ITS rDNA region was amplified and sequenced using ITS1 and ITS4 primers (White et al. 1990), and the beta-tubulin gene was amplified using the primers Bt2A and Bt2b (Glass and Donaldson 1995). Sanger sequencing reactions were performed in both directions using a 3730xl DNA Analyzer (Applied Biosystems™) at LANABIO, Biology Institute, National Autonomous University of Mexico (UNAM). Dehydrated specimens, cultures, and genomic DNA were deposited at the laboratory headed by Dr. Patricia Velez in the Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), and are available for research upon request (Table 2).

3 Sandy beaches

Mexico has a long coastline that covers around 15,069 km (considering the insular surface; CONABIO 2019) and includes tropical and temperate zones that sustain several economic activities (Martínez et al. 2006). This dynamic ecotone, characterized by strong environmental shifts in temperature, salinity, UV radiation, and substratum availability, harbors rich biotic assemblages which include a native fungal community represented mostly by arenicolous marine fungi that coexist with numerous facultative marine species (González and Herrera 1993; Walker and Robicheau 2021).

In terms of marine fungal diversity in beaches, few studies were carried out in Mexico before 2001, including Hyde (1992), Kohlmeyer (1968, 1969, 1983, 1984), Kohlmeyer and Kohlmeyer (1979), González and Herrera (1995) and González et al. (1998). Since 2001, investigation of arenicolous marine fungi has extended to 32 localities (including both impacted and pristine sites), in the Gulf of California (Velez et al. 2016a), the Caribbean Sea (González and Hanlin 2010; Velez et al. 2015a, 2016a), and the Gulf of Mexico (González et al. 2010; Velez et al. 2013, 2015b, 2016a,b). As a result, 27 species of fungi have been reported from Mexican coasts.

During the last two decades, beaches have been intensively explored for marine fungi. Particularly, the Gulf of Mexico stands as the top investigated region with 62 records (within the Ascomycota, Rozellomycota, Mucoromycota, and

Table 2: Top five ITS (internal transcribed spacer regions 1 and 2 of rDNA) and beta-tubulin gene hit reference sequences retrieved from the NCBI GenBank database through a BLAST search considered for taxonomic assignation of fungal isolates obtained from Mexican sandy beaches.

Isolate	ITS				Assigned OTU	Accession
	Reference accession	ID	% Identity	Coverage		
BA20	OM965340	*Alternaria angustiovoidea*	100	100	*Alternaria* sp.	OQ675147
	OP699757	*Alternaria alternata*	100	100		
	OP482359	*Alternaria alstroemeriae*	100	100		
	MZ742813	*Alternaria* sp.	100	100		
	MW474911	*Alternaria tenuissima*	100	100		
BA23	MG664756	*Didymella glomerata*	100	100	Didymellaceae sp.	OQ675148
	MK020673	*Epicoccum sorghinum*	99.79	100		
	NR_158278	*Epicoccum keratinophilum*	99.79	100		
	KY587324	*Epicoccum nigrum*	99.79	100		
	OP796486	*Didymella keratinophila*	99.79	100		
L14	MT582757	*Aspergillus tennesseensis*	100	100	*Aspergillus* sp. 1	OQ675149
	MT582748	*Aspergillus jensenii*	100	100		
	MT549678	*Aspergillus versicolor*	100	100		
	MK140695	*Aspergillus versicolor*	100	100		
	T102669	*Aspergillus* sp.	100	100		
SR13	MK027304	*Aspergillus versicolor*	99.82	100	*Aspergillus* sp. 2	OQ675150
	OW988460	*Aspergillus austroafricanus*	99.82	100		
	MH911388	*Aspergillus tabacinus*	99.63	100		
	ON008181	*Aspergillus versicolor*	99.63	100		
	LN898709	*Aspergillus protuberus*	99.45	100		
SR2	MN944461	*Parengyodontium album*	100	100	*Parengyodontium album*	OQ675151
	KP269065	*Parengyodontium album*	100	100		
	ON527249	*Parengyodontium album*	100	100		
	JF779670	*Parengyodontium album*	100	99		
	MT626052	*Parengyodontium album*	99.83	100		
BA22, BAPA3	NR_175013	*Corollospora portsaidica*	81.39	95	*Corollospora* sp.	OQ675152
	AB361031	*Corollospora portsaidica*	81.39	95		
	JN943387	*Corollospora maritima*	82.79	87		
	JN943386	*Corollospora gracilis*	87.15	87		
	MT569593	*Corollospora gracilis*	86.67	86		
		Beta-tubulin			**Assigned OTU**	**Accession**
BA23	EU552932	*Epicoccum plurivorum*	96.48	100	Didymellaceae sp.	OR351937
	EU552931	*Epicoccum plurivorum*	96.48	100		
	OM164105	*Similiphoma crystallifera*	96.14	100		
	KP185125	*Didymella curtisii*	95.42	100		
	LT593016	*Epicoccum* sp.	98.39	87		
SR2	MN944461	*Parengyodontium album*	100	100	*Parengyodontium album*	OR351939
	KP269065	*Parengyodontium album*	100	100		
	ON527249	*Parengyodontium album*	100	100		
	JF779670	*Parengyodontium album*	100	99		
	MT626052	*Parengyodontium album*	99.83	100		
BA22, BAPA3	NR_175013	*Corollospora portsaidica*	81.39	95	*Corollospora* sp.	OR351938
	AB361031	*Corollospora portsaidica*	81.39	95		
	JN943387	*Corollospora maritima*	82.79	87		
	JN943386	*Corollospora gracilis*	87.15	87		
	MT569593	*Corollospora gracilis*	86.67	86		

Chytridiomycota), followed by the Caribbean with 42 records (within the Ascomycota and Basidiomycota). Overall, these works point to the Caribbean and east beaches in the Gulf of Mexico as rich biodiverse spots, in contrast to the southern portion of the Gulf of Mexico where lower diversity levels might be explained by the presence of major polluted rivers and industrial complexes. Nevertheless, numerous coastal regions of the country remain unexplored, especially in the Pacific Ocean, which represents 68 % of the Mexican coastline. Further unexplored priority areas include natural reserves, sanctuaries, or heavily impacted zones, in the states of Oaxaca (La Escobilla and Morro Ayuta), Baja California (National Park Bahía de Loreto, and the biosphere reserve El Vizcaíno), Nayarit (Bahía de Banderas), and Colima (Revillagigedo Islands) (PROFEPA 2016; SEMARNAT 2021). As a result of our exploration of four localities in the Baja California Peninsula in August 2017, six taxa were discovered including a partially identified *Corollospora* sp. (Table 1). This fungus, previously reported by Velez et al. (2021) from Ensenada, Baja California, considerably diverges (morphologically and genetically) from all the described species within the genus, and perhaps represents a new species that should be further investigated (Figure 1).

Regional distribution patterns have been reported for fungal communities in the Gulf of Mexico by Velez et al. (2013), identifying taxa with: (1) wide distribution (*C. maritima sensu lato*); (2) restricted to the Yucatán Peninsula (*Arenariomyces triseptatus*); (3) associated with the occurrence of the seagrass *Thalassia testudinum* (*Lindra thalassiae*); and (4) restricted to the south of the state of Veracruz (*Corollospora gracilis* and *Lignincola laevis*). Moreover, local patterns have been described for Cozumel Island in the Caribbean (Velez et al. 2015a), and Tabasco State in the Gulf of Mexico (Velez et al. 2015b), suggesting that neighboring ecosystems represent an important source of assorted substrata, which promotes fungal proliferation.

Globally, *C. maritima sensu lato* has been accounted as a ubiquitous and most abundant species complex in Mexican beaches (González et al. 1998; Velez et al. 2013, 2015a,b). In this regard, the effect of environmental variables (e.g., temperature, average rainfall and salinity) on the occurrence of isolates from Tamaulipas, Veracruz, Tabasco, and Campeche was explored (Velez et al. 2013), describing particularities such as the ability of some species to grow and produce mature ascomata over a broad range of salinities. Transcriptomic data has demonstrated that isolates from Tabasco and Veracruz displayed high tolerance towards salinity fluctuations, upregulating GPI-anchored putative glucosidase and the aspartic-type endopeptidase genes when grown under freshwater conditions (Velez et al. 2015c). Furthermore, variables such as temperature, radiation, and moisture have been identified as key environmental parameters associated with the occurrence of one of the genetic lineages, which was distributed in Sonora, Yucatán, Tamaulipas, Baja California Sur, and Campeche (Velez et al. 2016a), confirming early observations on ecotypes (Bebout et al. 1987).

The presence of facultative marine fungi in beaches has been repeatedly reported, including potentially human pathogenic species (Velez et al. 2022b; Whitman et al. 2014). Numerous opportunistic human pathogenic fungi including *Arthrographis kalrae*, *Parengyodontium album*, *Neocosmospora solani, Scopulariopsis* sp., and *Exophiala* sp. have been reported from Mexican sandy beaches. This is a health risk in impacted beaches of Ensenada City, evidencing coastal wastewater contamination (Velez et al. 2021). In this sense, sand may act as a reservoir for potentially allergenic fungi and opportunistic human pathogenic fungi (Yee et al. 2016).

Unfortunately, beaches are increasingly impacted by anthropogenic pressures, mostly owing to urban and tourism development (Martínez et al. 2006; Tanahara

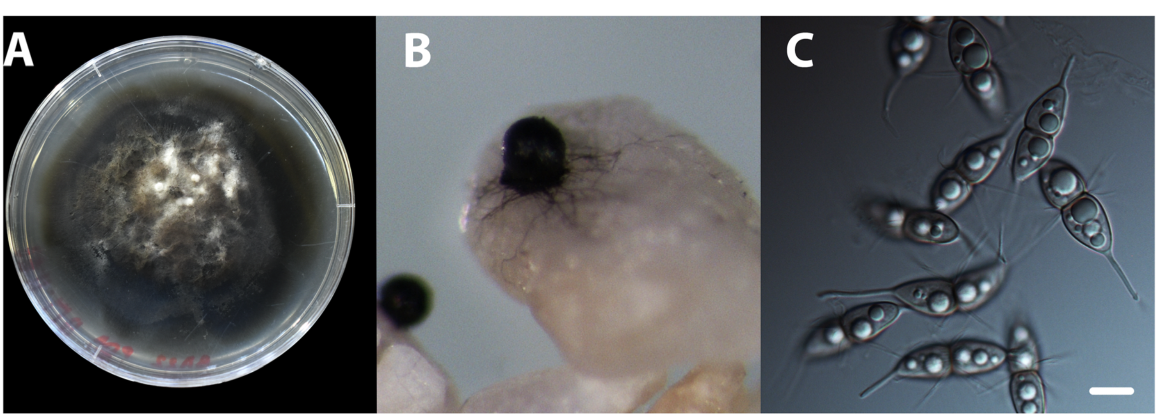


Figure 1: *Corollospora* sp. isolated from sand samples in Baja California, Mexico. (A) Axenic isolate on potato dextrose agar. (B) Ascoma attached to a sand grain. (C) One-septate, pigmented ascospores, scale bar = 17 μm.

et al. 2021), which poses major challenges to inventorying biodiversity. Nonetheless, recent studies have demonstrated that the new environmental setting resulting from the COVID-19 lockdown may restore the biological community of beaches previously impacted by human activity, hinting to their impressive resilience capacities (Soto et al. 2021). The potential application of intertidal autochthonous species as bioindicators has been proposed for an urban tourist beach in the Caribbean Sea, with high anthropogenic activities (González and Hanlin 2010; Ocaña et al. 2020). Long-term investigations incorporating arenicolous fungi could provide valuable data to confirm observations on the rapid recovery of Mexican tourist beaches in the Caribbean during the COVID-19 lockdown.

4 Deep-sea, brackish, and hypersaline coastal lagoons

Fungi in deep-sea ecosystems have developed adaptations to cope with extreme conditions such as high hydrostatic pressure, low temperature and pH, nutrient limitations, and high salinity (Raghukumar et al. 2010). Exploration of fungal diversity in the deep-sea is recent in Mexico. The first report from a vent field resulted as a peripheral finding from the evaluation of benthic eukaryotic diversity from sediments in the Guaymas Basin (27°1′388″N, 111°24′112″W), identifying fungal taxa based on nuclear small subunit rDNA (SSU) amplicon sequencing (Edgcomb et al. 2002). Data obtained from the ITS rDNA region hinted at high diversity levels (4421 OTUs) in deep-sea sediments from the Gulf of Mexico at depths between 1000 and 3500 m, where *Penicillium*, *Rhodotorula* and *Cladosporium* occurred as the dominant genera (Vargas-Gastélum et al. 2019). Subsequent efforts include the description of 2653 ITS amplicon sequence variants (ASVs) from hydrothermal vents in the Guaymas Basin, suggesting that fungal taxa were not linked with specific sample areas as Chytridiomycota (54 % of the total ASVs) and Agaricomycetes were widely distributed across the sample set (Ramírez et al. 2021). Recently, sediment samples from low- and high-temperature vent systems at the Pescadero Basin, Pescadero Transform Fault, and the Alarcón Rise, as well as an oxygen minimum zone in the southern Gulf of California were explored, where 102 ASVs principally affiliated with the Ascomycota and Basidiomycota were documented. The FUNGuild analysis of these data revealed characteristic assemblages in each ecosystem, which could be linked to site-specific processes that should be further investigated (Velez et al. 2022a). Likewise, 353 fungal ASVs from an oxygen minimum zone in the Mexican Tropical Pacific were reported with the Ascomycota as the most abundant phylum, followed by Basidiomycota. This work demonstrated both a bathymetric diversity pattern (nearshore subsamples showed higher diversity values) and a vertical diversity pattern (subsurface subsamples showed higher diversity values) in fungal diversity (Posadas 2023). Remarkably, all the above-mentioned culture-independent studies agree with the occurrence of a high proportion of widely distributed, uncultured phylotypes awaiting description. This represents a research orientation that needs to be further advanced.

A culture-independent study documented SSU sequences recovered from different water bodies including marine water column (depths of 134 m) and surface water in brackish and hypersaline coastal lagoons in Tamaulipas, Jalisco, Nayarit, and Chiapas. The data derived from this investigation identified Ascomycota (89.1 %) as the most frequently recovered phylum, followed by Chytridiomycota (8.1 %), Basidiomycota (2.8 %) and subphylum Mucoromycotina (1.3 %). The authors of this contribution highlighted the lack of culture-independent information on aquatic fungi for Mexico, and suggested that the occurrence of rare taxa could be explained by local adaptations (specialization) (Valderrama et al. 2016).

Culture-dependent investigations have also been conducted, revealing the occurrence of a new species *Aspergillus loretoensis* in sediments at 275 m depth in Baja California (González-Martínez et al. 2017). Also, fungi from deep-sea sediments in oil reserves in the Gulf of Mexico have been isolated, including: *Aureobasidium* sp., *Cladosporium* sp., *Penicillium* spp., and *Phialocephala* sp. (Velez et al. 2020); and *Alternaria* sp., *Aureobasidium* sp., *Cladosporium* spp., *Penicillium* spp., *Phialocephala* sp., and *Stemphylium* sp. (Romero-Hernández et al. 2021).

5 Marine fungal genetic resources

Although the universal definition of a “marine genetic resource” remains elusive, this concept represents a new frontier for genetic and biochemical information (Eugui and Meyer 2019). Marine fungi produce a variety of unique and biologically potent natural products including alkaloids, terpenoids, steroids, peptides, polyketides, and others (Arrieche et al. 2023). Hence, bioprospecting of marine fungi has emerged for their antitumor, anticancer, antimicrobial, and enzymatic activities, bioremediation potential, as well as in the production of several therapeutically bioactive agents (Devi and Thakur 2021). Mexican fungal isolates from the marine environments produce an array of fascinating natural products, displaying a remarkable metabolic plasticity. Secondary metabolites and bioactive compounds obtained from these fungi include N-methyl cyclic pentapeptides and dioxomorpholines with unique chemical structures and antimicrobial properties (Aparicio-Cuevas et al. 2017, 2019).

Population genetic analyses of *C. maritima sensu lato* based on the amplification of inter-simple sequence repeats suggested that Mexican beaches (mainly the Caribbean Sea) harbored a high genetic diversity and exclusive genetic clusters (Velez et al. 2016b). This result was subsequently confirmed by ITS sequencing, delimiting the occurrence of five genetic lineages with distinctive environmental preferences and an overlapping geographic distribution (Velez et al. 2016a). This remarkable genetic diversity within one obligate marine fungal species might offer interesting prospects for bioprospecting and natural product discovery.

Data obtained under the “one strain, many compounds” approach for a collection of fungal isolates obtained from deep-sea sediments of the Gulf of Mexico revealed that over 50 % of the tested extracts showed antimicrobial activity, particularly those grown at 4 °C in darkness. This finding confirmed that culture temperature is one of the primary factors driving variation of metabolomes, and a key to explore deep-sea fungal chemical diversity and antimicrobial potential (Nagano and Nagahama 2012; Villanueva-Silva et al. 2021).

The oil industry in Mexico represents a crucial economic activity (with a daily production of 1622 million barrels, Comisión Nacional de Hidrocarburos 2023) that unfortunately poses an imminent environmental risk. During spills, oil displays dynamic characteristics in the sea, spreading from coastal areas to deep-sea sediments (IARC 1989). Under this scenario, the identification of hydrocarbon degraders is mandatory to enhance the implementation of efficient bioremediation actions. Hydrocarbon tolerant fungi from deep-sea sediments in the Gulf of Mexico have been proposed as potential candidates for bioremediation. These fungi were proved to use aliphatic hydrocarbons as the sole carbon source (Velez et al. 2020), as well as heavy and extra-heavy crude oil (Romero-Hernández et al. 2021). Also, microbial biofouling and biocorrosion on a marine oil pipeline in the Gulf of Mexico were studied, identifying fungi (Pucciniaceae, Clavariaceae, and Onygenaceae) as important components of marine corrosion processes (Avelino-Jiménez et al. 2023). This presents a formidable challenge in terms of marine materials damaged by the action of microbial consortia.

6 Functional diversity

The intertidal zone accumulates assorted organic debris consisting mainly of lignin, cellulose, and chitin (Kohlmeyer and Kohlmeyer 1979). Accordingly, fungal diversity on Mexican beaches largely consists of saprobiotic species such as *Corollospora pseudopulchella, C. gracilis, Leptosphaerella* sp.*, L. thalassiae, Lineolata rhizophorae* and *Lulworthia* sp. (González et al. 2001; Velez et al. 2013, 2015c); as well as terrestrial borne opportunistically pathogenic fungi such as *A. kalrae, P. album, N. solani, Scopulariopsis* sp., and *Exophiala* sp. (Velez et al. 2021). Interestingly, substrata specificity in arenicolous species has been documented including *L. thalassiae* (*T. testudinum*) and *C. gracilis* (*Sargassum* sp.) (Velez et al. 2013, 2021). The ecological implications of beach wrack cleaning (directional selection of species with no substrata specificity) have been discussed by Velez et al. (2021).

Hydrothermal vents are frequently associated with endemic faunal assemblages fulfilling unique functions (Desbruyères et al. 2001). However, fungal functional roles in this ecosystem remain poorly explored. Velez et al. (2022a) inferred functional guilds from ITS-amplicon dataset in deep-sea hydrothermal vents and an oxygen minimum zone, as animal pathogens, endophytes, plant pathogens, among others, and documented an uncultured fungal group with a putative limited distribution to deep-sea environments, such as methane cold-seeps, anoxic bacterial mats, and deep-sea sediments. The results presented in this work evidenced that a diverse and functionally multifaceted microfungal community inhabited these deep-sea extreme ecosystems, and that the conserved core of fungal taxa across ecosystems comprised barely 3.9 % of the total community. A subsequent investigation approached the analysis of stable isotopes of carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and sulfur ($\delta^{34}S$) in isolates obtained from these deep-sea vent systems, showing that 60 % of the isolates relied on mixed carbon sources fixed by the Calvin–Benson–Bassham and the reductive Tricarboxylic Acid (rTCA) cycles, whereas the remaining 40 % relied exclusively on rTCA carbon (Salcedo et al. 2023). The $\delta^{15}N$ and $\delta^{34}S$ values in this work suggested a dependence on local and external nitrogen sources and the assimilation of chemosynthetic and photosynthetic inputs. Remarkably, fungal $\delta^{13}C$ and $\delta^{15}N$ overlapped with those of primary and secondary vent macroconsumers, implying the assimilation of bacterial and invertebrate necromass and their ecological role as parasites (Salcedo et al. 2023). More research is needed to obtain a full picture of fungal diversity in this habitat, and to understand compositional differences across ecosystems.

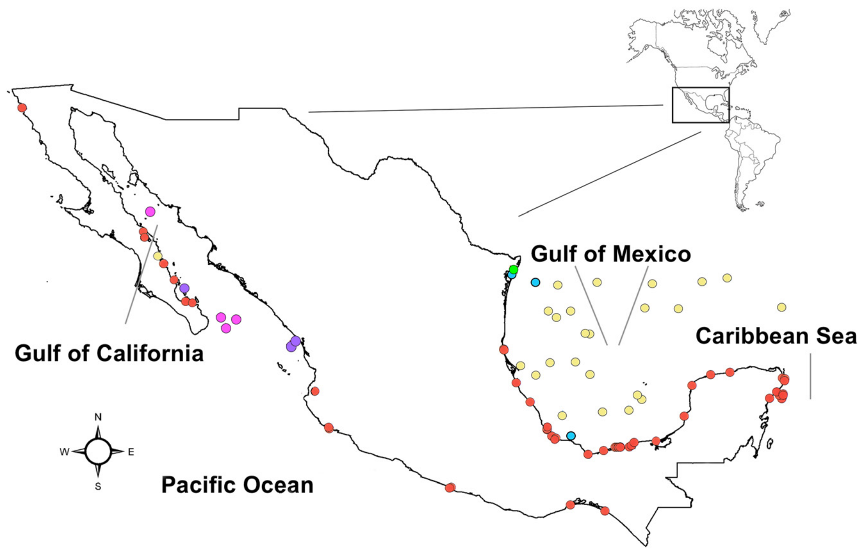


Figure 2: Coastal and oceanic localities explored for marine fungi in Mexico from 1992 to 2023, including deep-sea plains (yellow circles), hypersaline sea (green circle), oxygen minimum zones (purple circles), sandy beaches (red circles), water column (blue circles), hydrothermal vents (pink circles).

7 Conclusions

Over the past ~75 years the investigation of marine fungal diversity in Mexico has focused on the exploration of coastal environments; however, recent studies in deep-sea plains, oxygen minimum zones, hydrothermal vents, and water columns have proved that these environments are fertile niches for fungi (Figure 2). Mexican marine mycodiversity reflects the heterogeneous environmental settings resulting from its neotropical biogeographical region influenced by two oceans, Atlantic and Pacific, and two internal seas, the Gulf of California and the Gulf of Mexico, all with different ecological conditions (CONABIO 2019). Culture-dependent approaches are needed to determine fungal tolerance towards shifts in key marine conditions, including changes in physicochemical variables, climate change and anthropogenic pressures.

Acknowledgments: We thank Vianney López Pacheco for assistance in the sampling of the arenicolous material in Ensenada, Baja California. We would also like to acknowledge the anonymous reviewers for their valuable comments on earlier versions of the manuscript.
Research ethics: Not applicable.
Informed consent: Not applicable.
Author contributions: PV designed the work. PV, JO and AB generated the data. All the authors contributed to the analysis and interpretation of the data, drafting the work and approved the version to be published. The authors have accepted responsibility for the entire content of this manuscript and approved its submission.
Competing interests: The authors declare no conflicts of interest regarding this article.
Research funding: This work was funded by DGAPA-PAPIIT-UNAM IN200921. JO acknowledges the academic grant from the Mexican National Council for Science and Technology CONAHCYT (number 882658) for his studies in the Graduate Program in Ocean Sciences and Limnology at the National Autonomous University of Mexico. AB received an academic grant from the Mexican National Council for Science and Technology CONAHCYT (number 830232) for her studies in the Graduate Program in Biological Sciences at the National Autonomous University of Mexico.
Data availability: The generated sequences are publicly available under the accession numbers OQ675147- OQ675152 and OR351937- OR351938 in the NCBI GenBank database.

References

Amend, A.S., Barshis, D.J., and Oliver, T.A. (2012). Coral-associated marine fungi form novel lineages and heterogeneous assemblages. ISME J. 6: 1291–1301.

Aparicio-Cuevas, M.A., Rivero-Cruz, I., Sánchez-Castellanos, M., Menéndez, D., Huzefa, A.R., Joseph-Nathan, P., González, M.C., and Figueroa, M. (2017). Dioxomorpholines and derivatives from a marine-facultative *Aspergillus* species. J. Nat. Prod. 80: 2311–2318.

Aparicio-Cuevas, M.A., González, M.C., Raja, H.A., Rivero-Cruz, I., Kurina, S.J., Burdette, J.E., Oberlies, N.H., and Figueroa, M. (2019). Metabolites from the marine-facultative *Aspergillus sp*. MEXU 27854 and *Gymnoascus hyalinosporus* MEXU 29901 from Caleta Bay, Mexico. Tetrahedron Lett. 60: 1649–1652.

Arrieche, D., Cabrera-Pardo, J.R., San-Martin, A., Carrasco, H., and Taborga, L. (2023). Natural products from Chilean and Antarctic marine fungi and their biomedical relevance. Mar. Drugs 21: 98.

Avelino-Jiménez, I.A., Hernández-Maya, L., Larios-Serrato, V., Quej-Ake, L., Castelán-Sánchez, H., Herrera-Diaz, J., Garibay-Flebes, V., Rivera-Olvera, J.N., Zavala-Olivares, G., and Zapata-Peñasco, I. (2023). Biofouling and biocorrosion by microbiota from a marine oil pipeline:

a metagenomic and proteomic approach. J. Environ. Chem. Eng. 11: 109413.

Bebout, B., Schatz, S., Kohlmeyer, J., and Haibach, M. (1987). Temperature-dependent growth in isolates of *Corollospora maritima* Werderm. (Ascomycetes) from different geographical regions. J. Exp. Mar. Biol. Ecol. 106: 203–210.

CNH (Comisión Nacional de Hidrocarburos) (2023). *Centro Nacional de Información de Hidrocarburos (CNIH)*, Ciudad de México, Available at: <https://www.gob.mx/cnh> (Accessed 27 Jan 2023).

CONABIO. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (2019). CONABIO genera nueva cartografía de la línea de costa de México. Centro Nacional de Información de Hidrocarburos (CNIH), Mexico City.

Dawson, E.Y. (1949). Contributions toward a marine flora of the southern California Channel Islands, I–III. University of Southern California. Allan Hancock Foundation, Occasional Paper 8, Los Angeles, CA, pp. 1–57.

Desbruyères, P., Biscoito, M., Caprais, J.C., Colaço, A., Comtet, T., Crassous, P., Fouquet, Y., Khripounoff, A., Le Bris, N., Olu, K., et al. (2001). Variations in deep-sea hydrothermal vents communities on the Mid-Atlantic Ridge near the Azores plateau. Deep Sea Res., Part I 48: 1325–1346.

Devi, P. and Thakur, N. (2021). Bioprospecting of marine fungi. In: Satyanarayana, T., Deshmukh, S.K., and Deshpande, M.V. (Eds.), *Progress in mycology: biology and biotechnological applications*. Springer, Singapore, pp. 545–571.

Doyle, J.J. and Doyle, J.L. (1987). A rapid DNA isolation procedure for small quantities of fresh leaf tissue. Phytochem. Bull. 19: 11–15.

Edgcomb, V.P., Kysela, D.T., Teske, A., Vera, A., and Sogin, M.L. (2002). Benthic eukaryotic diversity in the Guaymas Basin hydrothermal vent environment. Proc. Natl. Acad. Sci. U.S.A. 99: 7658–7662.

Eugui, D.V. and Meyer, H. (2019). Marine genetic resources within national jurisdiction: flagging implications for access and benefit sharing and analysing patent trends. In: Correa, C. and Seuba, X. (Eds.), *Intellectual property and development: understanding the interfaces*. Springer, Singapore, pp. 405–431.

Faber, B. and Gaubert, C. (2019). Tourism and economic development: evidence from Mexico's coastline. Am. Econ. Rev. 109: 2245–2293.

Fajardo-Hernández, C.A., Khan, F.S.T., Flores-Bocanegra, L., Prieto-Davó, A., Wan, B., Ma, R., Qader, M., Villanueva-Silva, R., Martínez-Cárdenas, A., López-Lobato, M.A., et al. (2022). Insights into the chemical diversity of selected fungi from the Tza Itzá Cenote of the Yucatan Peninsula. ACS Omega 7: 12171–12185.

Gladfelter, A.S., James, T.Y., and Amend, A.S. (2019). Marine fungi. Curr. Biol. 29: R191–R195.

Glass, N.L. and Donaldson, G.C. (1995). Development of primer sets designed for use with the PCR to amplify conserved genes from filamentous ascomycetes. Appl. Environ. Microbiol. 61: 1323–1330.

González, M.C. (2009). Free-living, saprobiotic filamentous fungi of the Gulf of Mexico. In: Felder, D.L. and Camp, D.D. (Eds.), *Gulf of Mexico origin, waters, and biota*. Texas A and M University Press, College Station, Texas, pp. 81–85.

González, M.C. and Hanlin, R.T. (2010). Potential use of marine arenicolous ascomycetes as bioindicators of ecosystem disturbance on sandy Cancun beaches: *Corollospora maritima* as a candidate species. Bot. Mar. 53: 577–580.

González, M.C. and Herrera, T. (1993). Endopsammophilous micromycetes from barra de navidad, Jalisco, México. Rev. Mex. Micol. 9: 19–33.

González, M.C. and Herrera, T. (1995). Lignicolous marine micromycetes from barra de navidad coastal lagoon, state of Jalisco, México. Rev. Mex. Micol. 11: 145–154.

González, M.C. and Herrera, T. (2010). Potential use of marine arenicolous ascomycetes as bioindicators of ecosystem disturbance on sandy Cancun beaches: *Corollospora maritima* as a candidate species. Bot. Mar. 53: 577–580.

González, M.C., Herrera, T., Ulloa, M., and Hanlin, R.T. (1998). Abundance and diversity of microfungi in three coastal beaches of Mexico. Mycoscience 39: 115–121.

González, M.C., Hanlin, R.T., Herrera, T., and Ulloa, M. (2000). Fungi colonizing hair-baits from three coastal beaches of Mexico. Mycoscience 4: 259–262.

González, M.C., Hanlin, R.T., Herrera, T., and Ulloa, M. (2001). A checklist of high marine fungi of Mexico. Mycotaxon 80: 241–253.

González, M.C., Mureta-Figueroa, N., Medina-Ortiz, C., and Hanlin, R.T. (2010). New record of *Circinella muscae* from a hydrocarbon polluted beach of Tabasco, Mexico. Mycotaxon 113: 111–117.

González-Martínez, S., Soria, I., Ayala, N., and Portillo-López, A. (2017). Culturable halotolerant fungal isolates from Southern California Gulf sediments. Open Agric. 2: 292–299.

González-Martínez, S., Galindo-Sánchez, C., López-Landavery, E., Paniagua-Chávez, C., and Portillo-López, A. (2019). *Aspergillus loretoensis*, a single isolate from marine sediment of Loreto Bay, Baja California Sur, México resulting as a new obligate halophile species. Extremophiles 23: 557–568.

Gutiérrez, M.H., Jara, A.M., and Pantoja, S. (2016). Fungal parasites infect marine diatoms in the upwelling ecosystem of the Humboldt current system off central Chile. Environ. Microbiol. 18: 1646–1653.

Hernández, M.J. (2019). *Diversidad microbiana cultivable e interacciones ecológicas entre bacterias y hongos de ventilas hidrotermales y fondo marino del Sur del Golfo de California*, Undergrade thesis. Universidad Nacional Autónoma de México, México City.

Höhnk, W. (1955). Niedere Pilze vom Watt und Meeresgrund (Chytridiales und Thraustochytriaceae). Naturwissenschaften 42: 348–349.

Hughes, G.C. (1974). Geographical distribution of the higher marine fungi. Veröff. Inst. Meeresforsch. Bremerhaven Suppl. 5: 419–441.

Hughes, G.C. (1986). Biogeography and the marine fungi. In: Moss, S.T. (Ed.), *The biology of marine fungi*. Cambridge University Press, Cambridge, pp. 275–295.

Hyde, K.D. (1992). Intertidal mangrove fungi from the west coast of Mexico, including one new genus and two new species. Mycol. Res. 96: 25–30.

Hyde, K.D., Jones, E.B.G., Leaño, E., Pointing, S.B., Poonyth, A.D., and Vrijmoed, L.L.P. (1998). Role of fungi in marine ecosystems. Biodivers. Conserv. 7: 1147–1161.

Hyde, K.D., Sarma, V.V., and Jones, E.B. (2000). Morphology and taxonomy of higher marine fungi. In: Hyde, K.D. and Pointing, S.B. (Eds.), *Marine mycology a practical approach*. Fungal Diversity Press, Hong Kong, pp. 172–204.

IARC (International Agency for Research on Cancer) (1989). *Monographs on the evaluation of the carcinogenic risk of chemicals to man: occupational exposures to petroleum refining; crude oil and major petroleum fuels*, Vol. 45. IARC, Lyon.

Jones, E.B.G. and Pang, K.L. (2012). Tropical aquatic fungi. Biodivers. Conserv. 21: 2403–2423.

Jones, E.B.G., Pang, K.L., Abdel-Wahab, M.A., Scholz, B., Hyde, K.D., Boekhout, T., Ebel, R., Rateb, M.E., Henderson, L., Sakayaroj, J., et al. (2019). An online resource for marine fungi. Fungal Diversity 96: 347–433.

Jones, E.B.G., Ramakrishna, S., Vikineswary, S., Das, D., Bahkali, A.H., Guo, S.Y., and Pang, K.L. (2022). How do fungi survive in the sea and respond to climate change? J. Fungi 8: 291.

Koch, J. (1974). Marine fungi of driftwood from the west coast of Jutland, Denmark. Friesia 10: 209–250.

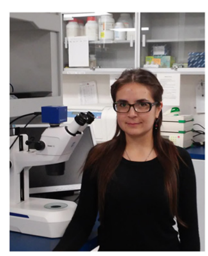
Kohlmeyer, J. (1966). Ecological observations on arenicolous marine fungi. Z. Allg. Mikrobiol. 6: 95–106.
Kohlmeyer, J. (1967). Intertidal and phycophilous fungi from Tenerife (Canary Islands). Trans. Br. Mycol. Soc. 50: 137–147.
Kohlmeyer, J. (1968). Marine fungi from the tropics. Mycologia 60: 252–270.
Kohlmeyer, J. (1969). Marine fungi of Hawaii including the new genus *Helicascus*. Can. J. Bot. 47: 1469–1487.
Kohlmeyer, J. (1975). Revision of algicolous *Zignoella* spp. and description of *Pontogeneia* gen. nov. (Ascomycetes). Bot. Jahrb. für Syst. Pflanzengesch. Pflanzengeogr. 96: 200–211.
Kohlmeyer, J. (1976). Marine fungi from South America. Mitt. Inst. Colombo-Alemán Invest. Cient. 8: 33–39.
Kohlmeyer, J. (1980). Tropical and subtropical filamentous fungi of the Western Atlantic Ocean. Bot. Mar. 23: 529–544.
Kohlmeyer, J. (1981). Marine fungi from Martinique. Can. J. Bot. 59: 1314–1321.
Kohlmeyer, J. (1983). Geography of marine fungi. Aust. J. Bot. Suppl. Ser. 13: 67–76.
Kohlmeyer, J. (1984). Tropical marine fungi. Mar. Ecol. 5: 329–378.
Kohlmeyer, J. and Kohlmeyer, E. (1971). Marine fungi from tropical America and Africa. Mycologia 63: 831–861.
Kohlmeyer, J. and Kohlmeyer, E. (1977). Bermuda marine fungi. Trans. Br. Mycol. Soc. 68: 207–219.
Kohlmeyer, J. and Kohlmeyer, E. (1979). *Marine mycology. The higher fungi*. Academic Press, New York.
Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1987a). Marine fungi from Aldabra, the Galapagos, and other tropical islands. Can. J. Bot. 65: 571–582.
Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1987b). Marine fungi from Belize with a description of two new genera of ascomycetes. Bot. Mar. 30: 195–204.
Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1987c). Reflections on the genus *Corollospora* (ascomycetes). Trans. Br. Mycol. Soc. 88: 181–188.
Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1991). Illustrated key to the filamentous higher marine fungi. Bot. Mar. 34: 1–61.
Martínez, M.L., GallegoFernández, J.B., GarcíaFranco, J.G., Moctezuma, C., and Jiménez, C.D. (2006). Assessment of coastal dune vulnerability to natural and anthropogenic disturbances along the Gulf of Mexico. Environ. Conserv. 33: 109–117.
Mason, E. (1928). Note on the presence of mycorrhiza in the roots of salt marsh plants. New Phytol. 27: 193–195.
Meyers, S.P. (1957). Taxonomy of marine Pyrenomycetes. Mycologia 49: 475–528.
Mittermeier, R.A., Robles, G.P., and Mittermeier, C.G. (1999). Megadiversity: earth's biologically wealthiest nations. Secretaría de Medio Ambiente y Recursos Naturales, Mexico City, pp. 120–136.
Nagano, Y. and Nagahama, T. (2012). Fungal diversity in deep-sea extreme environments. Fungal Ecol. 5: 463–471.
Ocaña, F.A., Jesús-Navarrete, A., and Hernández-Arana, H.A. (2020). Co-occurring factors affecting ghost crab density at four sandy beaches in the Mexican Caribbean. Reg. Stud. Mar. Sci. 36: 2352–2855.
Pang, K.L., Overy, D.P., Gareth, J.E., Calado, M.L., Burgaud, G., Walker, A.K., Johnson, J.A., Kerr, R.G., Cha, H., and Bills, G.F. (2016). 'Marine fungi' and 'marine-derived fungi' in natural product chemistry research: toward a new consensual definition. Fungal Biol. Rev. 30: 163–175.
Pang, K.L., Hassett, B.T., Shaumi, A., Guo, S.Y., Sakayaroj, J., Chiang, M.W.L., Yang, C.H., and Jones, E.B.G. (2021). Pathogenic fungi of marine animals: a taxonomic perspective. Fungal Biol. Rev. 38: 92–106.
Pang, K.L., Jones, E.B.G., Abdel-Wahab, M.A., Adams, S.J., Alves, A., Azevedo, E., Bahkali, A.H., Barata, M., Burgaud, G., Caeiro, M.F., et al. (2023). Recent progress in marine mycological research in different countries, and prospects for future developments worldwide. Bot. Mar. 66: 239–269.
Pérez-Ortega, S., Garrido-Benavent, I., Grube, M., Olmo, R., and De Los Ríos, A. (2016). Hidden diversity of marine borderline lichens and a new order of fungi. *Collemopsidiales (Dothideomyceta)*. Fungal Diversity 80: 285–300.
Portillo-López, A. and Gonzalez-Martinez, S. (2021). Marine fungi from different habitats recorded from 2001 to date in Mexico. J. Microbiol. Exp. 9: 34–37.
Posadas, J. (2023). *Evaluación de la diversidad fúngica en sedimento de una zona mínima de oxígeno del Océano Pacífico, costa de Mazatlán, zona económica exclusiva de México,* Masters thesis. Mexico City, Universidad Nacional Autónoma de México.
PROFEPA (Procuraduría Federal de Protección al Ambiente) (2016). Profepa protege tortugas marinas en el santuario de la escobilla y playa morro ayuta, Oaxaca. Available at: <https://www.profepa.gob.mx/innovaportal/v/8869/1/mx/protege_profepa_mas_de_382_mil_nidos_de_tortuga_marina_durante_siete_arribadas_en_playas_de_oaxaca.html> (Accessed 27 Jan 2023).
Raghukumar, C. (1986). Thraustochytrid fungi associated with marine algae. Indian J. Mar. Sci. 15: 121–122.
Raghukumar, C., Damare, S.R., and Singh, P. (2010). A review on deep-sea fungi: occurrence, diversity and adaptations. Bot. Mar. 53: 479–492.
Ramírez, G.A., Mara, P., Sehein, T., Wegener, G., Chambers, C.R., Joye, S., Peterson, R.N., Philippe, A., Burgaud, G., Edgcomb, V.P., et al. (2021). Environmental factors shaping bacterial, archaeal and fungal community structure in hydrothermal sediments of Guaymas Basin, Gulf of California. PLoS One 16: e0256321.
Romero-Hernández, L., Velez, P., Betanzo-Gutiérrez, I., Camacho-López, M.D., Vázquez-Duhalt, R., and Riquelme, M. (2021). Extra-heavy crude oil degradation by *Alternaria* sp. isolated from deep-sea sediments of the Gulf of Mexico. Appl. Sci. 11: 6090.
Salcedo, D.L., Velez, P., Hernandez-Monroy, A., and Soto, L.A. (2023). Insights into the functional role of fungi in deep-sea hydrothermal vents through the analysis of stable isotopes of carbon, nitrogen, and sulfur. Fungal Ecol. 64: 101250.
Schoch, C.L., Seifert, K.A., Huhndorf, S., Robert, V., Spouge, J.L., Levesque, C.A., Chen, W., Bolchacova, E., Voigt, K., Crous, P.W., et al. (2012). Nuclear ribosomal internal transcribed spacer (ITS) region as a universal DNA barcode marker for Fungi. Proc. Natl. Acad. Sci. 109: 6241–6246.
SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales) (2021). México, santuario de gigantes de los mares. Available at: <https://www.gob.mx/semarnat/articulos/mexico-santuario-de-gigantes-de-los-mares> (Accessed 19 Oct 2022).
Soto, E.H., Botero, C.M., Milan, C.B., Rodríguez-Santiago, A., Palacios-Moreno, M., Díaz-Ferguson, E., Velázquez, Y.R., Abbehusenh, A., Guerra-Castro, E., Simoes, N., et al. (2021). How does the beach ecosystem change without tourists during COVID-19 lockdown? Biol. Conserv. 255: 108972.
Tanahara, S., Canino-Herrera, S.R., Durazo, R., Félix-Bermúdez, A., Vivanco-Aranda, M., Morales-Estrada, E., and Lugo-Ibarra, K.C. (2021). Spatial and temporal variations in water quality of Todos Santos Bay, northwestern Baja California, Mexico. Mar. Pollut. Bull. 173: 113148.
Valderrama, B., Paredes-Valdeza, G., Rodríguez, R., Romero-Guidob, C., Martínez, F., Martínez-Romero, J., Guerrero-Galvánd, S., Mendoza-Herrera, A., and Folch-Mallol, J.L. (2016). Assessment of non-cultured aquatic fungal diversity from different habitats in Mexico. Rev. Mex. Biodivers. 87: 18–28.

Vargas-Gastélum, L., Chong-Robles, J., Lago-Lestón, A., Darcy, J.L., Amend, A.S., and Riquelme, M. (2019). Targeted ITS1 sequencing unravels the mycodiversity of deep-sea sediments from Gulf of Mexico. Environ. Microbiol. 21: 4046–4061.
Velez, P., González, M.C., Rosique-Gil, E., Cifuentes, J., Reyes-Montes, M.R., Capello-García, S., and Hanlin, R.T. (2013). Community structure and diversity of marine ascomycetes from coastal beaches of the southern Gulf of Mexico. Fungal Ecol. 6: 513–521.
Velez, P., González, M.C., Cifuentes, J., Rosique-Gil, E., and Hanlin, R.T. (2015a). Diversity of sand inhabiting marine ascomycetes in some tourist beaches on Cozumel Island, Mexico. Mycoscience 56: 136–140.
Velez, P., González, M.C., Capello-García, S., Rosique-Gil, E., and Hanlin, R.T. (2015b). Diversity of marine ascomycetes from the disturbed sandy beaches of Tabasco, Mexico. J. Mar. Biol. Assoc. U.K. 95: 897–903.
Velez, P., Alejandri-Ramírez, N.D., González, M.C., Estrada, K.J., Sanchez-Flores, A., and Dinkova, T.D. (2015c). Comparative transcriptome analysis of the cosmopolitan marine fungus *Corollospora maritima* under two physiological conditions. G3-Genes, Genomes, Genet. 5: 1805–1814.
Velez, P., Gasca-Pineda, J., Nakagiri, A., Hanlin, R.T., and González, M.C. (2016a). Genetic diversity and population structure of *Corollospora maritima sensu lato*: new insights from population genetics. Bot. Mar. 59: 307–320.
Velez, P., Quintero, C.A., Merino, G., Gasca-Pineda, J., and González, M.C. (2016b). An ISSR-based approach to assess genetic diversity in the marine arenicolous fungus *Corollospora maritima sensu lato*. Mycoscience 57: 187–195.
Velez, P., Gasca, J., and Riquelme, M. (2020). Cultivable fungi from deep-sea oil reserves in the Gulf of Mexico: genetic signatures in response to hydrocarbons. Mar. Environ. Res. 153: 104816.
Velez, P., Walker, A.K., Gasca-Pineda, J., Barrios, A., Divanli, D., González, M.C., and Nakagiri, A. (2021). Fine-scale temporal variation of intertidal marine fungal community structure: insights from an impacted Baja California sandy beach in Mexico. Mar. Biodivers. 51: 6.
Velez, P., Salcedo, D., Espinosa-Asuar, L., Gasca-Pineda, J., Hernandez-Monroy, A., and Soto, L.A. (2022a). Fungal diversity in sediments from deep-sea extreme ecosystems: insights into low- and high-temperature hydrothermal vents, and an oxygen minimum zone in the southern Gulf of California, Mexico. Front. Mar. Sci. 9: 802634.
Velez, P., Walker, A.K., González, M.C., Narayanan, S.S.S., and Nakagiri, A. (2022b). In depth review of the ecology of arenicolous marine fungi. Fungal Ecol. 60: 101164.
Villanueva-Silva, R., Velez, P., Riquelme, M., Fajardo-Hernández, C.A., Martínez-Cárdenas, A., Arista-Romero, A., Wan, B., Ma, R., Qader, M., Franzblau, S.G., et al. (2021). Chemical diversity and antimicrobial potential of cultivable fungi from deep-sea sediments of the Gulf of Mexico. Molecules 26: 7328.
Walker, A.K. and Robicheau, B.M. (2021). Fungal diversity and community structure from coastal and barrier island beaches in the United States Gulf of Mexico. Sci. Rep. 11: 3889.
Werdermann, E. (1922). *Corollospora maritima* Werd., ein salzliebender Pilz von der Nordseeküste. Notizbl. Königl. Bot. Gart. Berlin 73: 248–250.
White, T.J., Bruns, T., Lee, S., and Taylor, J. (1990). Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis, M.A., Gelfand, D.H., Sninsky, J.J., and White, T.J. (Eds.), *PCR protocols: a guide to methods and applications*. Academic Press, New York, pp. 315–322.
Whitman, R.L., Harwood, V.J., Edge, T.A., Nevers, M.B., Byappanahalli, M., Vijayavel, K., Brandão, J., Sadowsky, M.J., Alm, E.W., Crowe, A., et al. (2014). Microbes in beach sands: integrating environment, ecology and public health. Rev. Environ. Sci. Biotechnol. 13: 329–368.
Yee, T.L., Tajuddin, R., Nor, N.M.I.M., Mohd, M.H., and Zakaria, L. (2016). Filamentous ascomycete and basidiomycete fungi from beach sand. Rendiconti Lincei 27: 603–607.

Bionotes

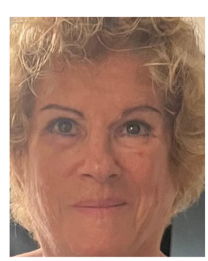
Julio Olguin
Posgrado en Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Coyoacán, Mexico City, 04510, Mexico
Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México, Coyoacán, Mexico City, 04510, Mexico

Julio Olguin received his B.S. (2017) and M.S. (2022) degrees from UNAM, Mexico. Currently, he is a PhD student in the Graduate School in Marine Sciences and Limnology, National Autonomous University of Mexico under the mentorship of Professor Patricia Velez. His research focuses on the bioremediation of Mexican marine ecosystems contaminated with hydrocarbons and crude oil, studying fungi obtained from the intertidal zone, hydrothermal vents, and beaches.



Patricia Velez
Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México, Coyoacán, Mexico City, 04510, Mexico
pvelez@ib.unam.mx
https://orcid.org/0000-0002-4449-8977

Dr. Patricia Velez earned her B.S. (2008), M.S. (2010), and Ph.D. (2014) degrees in Biological Sciences from the UNAM for her work on arenicolous marine fungi. Next, she performed two postdoctoral stays at the UNAM and the CICESE studying molecular ecology of freshwater and deep-sea fungi respectively. She is now a faculty member and full-time researcher at the Institute of Biology, UNAM where her work aims to explore the diversity, ecology and potential utilization of fungal communities, particularly in marine ecosystems.



Vivianne Solís-Weiss
Unidad Académica de Sistemas Arrecifales, Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de Mexico, Puerto Morelos, 77580, Mexico

Vivianne Solís-Weiss holds a PhD in Oceanography (1975, France). Postdocs: Israel 1975–1977, Trieste 2002–2004; sabbaticals: DC-USA (1986), Trieste (2000), Paris (2003). She is a Mexican Academy of Sciences member since 1993, Senior Professor and Researcher, and Head of Lab. She has over 220 publications and supervised 55 theses. Dr. Solís-Weiss is Head of Research projects in marine ecosystems in Mexican seas and coasts (cenotes to Deepsea). She has described more than 65 new species of invertebrates, is a co-discoverer of seagrasses pollination by invertebrates and presently involved in *Sargassum*, microplastics and marine fungi. She is fluent in 5 languages.

Allison K. Walker
Department of Biology, Acadia University, 33 Westwood Avenue, Wolfville, Nova Scotia, B4P 2R6, Canada
https://orcid.org/0000-0002-5061-361X

Professor Allison K. Walker trained at the University of Toronto, Canada and the USDA Systematic Botany and Mycology Laboratory, USA. She completed her graduate training in marine fungi at the University of Southern Mississippi, followed by postdoctoral research with David Miller and Keith Seifert (Ottawa) studying fungal endophytes. Now Full Professor at Acadia University, she serves as Director of the E.C. Smith Herbarium. She and her students study intertidal fungal biodiversity and ecology, focusing on salt marshes and endophytic fungi.

María C. González
Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México, Coyoacán, Mexico City, 04510, Mexico

Dr. María C. González is a faculty member and full-time researcher at the Institute of Biology-National Autonomous University of Mexico. She is a mycologist interested in studying the Mexican marine and freshwater Ascomycota diversity that inhabits ecotones of coastal and lentic ecosystems, respectively. She has published more than 55 articles in peer-reviewed journals and has served as the advisor for more than 15 graduate theses.