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Distribution and occurrence of Ascomycetes in Mexico

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Abstract: Mexico, with a land surface area of 1.97 M sq. km., has a topography that varies from high plains in the north, to tall volcanic mountains in the south-central region, to lowlands in the south, as well as extensive coastlines. Southern Mexico is the area where the temperate climate of North America unites with the tropical climate of Central and South America, resulting in a highly diverse ecosystem that supports an abundant biota, including ascomycetes. The mycological literature was reviewed for records of ascomycetes from Mexico, which yielded 1,331 species plus 24 varieties, for a total of 1,355 identified taxa of ascomycetes known from the country. Approximately 35% of these are lichenized. The anamorphic ascomycetes were not included in this compilation. Taxonomically, these ascomycetes are distributed among 414 genera belonging to 41 orders and 126 families. The Xylariales is the best studied group, with 100 species of *Xylaria* and 48 species of *Hypoxylon* recorded. Other common genera are *Parmotrema*

(36), *Laboulbenia* (32), *Cladonia* (30), *Podospora* (29), *Heterodermia* (27), *Meliola* (22), *Sporormiella* (21) and *Hypotrachyna* (21). *Peziza* and *Morchella* are the most common discomycetes, with 14 and 13 species, respectively. With regard to geographical distribution, the most explored areas in the country are the State of Veracruz, the State of Mexico, the State of Oaxaca, and the State of Chiapas located in the central-southeast region of the country, and the least studied areas are the State of Nayarit, the State of Aguascalientes, and the Peninsula of Baja California.

Key Words: Ascomycota, biodiversity, fungal diversity, fungal inventory, Mexico, mycology

Introduction: The ascomycetes are considered the most diverse and ecologically important group of fungi, with worldwide biogeographic distribution. They represent the largest of the major groups of true fungi and they occur in all kinds of ecological habitats, continental and oceanic, as saprobes, parasites and symbionts, although their main function is as saprobes that contribute to the process of degradation of organic matter and C/N cycling. Also, they have economic relevance as potential sources of novel bioactive metabolites that may have pharmaceutical and industrial applications. Based on data in Kirk et al. (2001), the ascomycetes comprise ca. 72% of the accepted genera of fungi and 60% of the species, and when the ascomycetous mitosporic fungi are included, these figures are even higher.

Mexico has a land surface area of 1,972,544 sq. km. The country is unique in that it lies on the confluence of the North American and South American tectonic plates that unite the two continents. The collision of these two plates resulted in the formation of an area of tall volcanic mountains across the south-central region of the country (Ferrusquía Villafranca, 1998). More importantly biologically, this united the temperate climate of North America with the tropical climate of Central and South America, giving the country an unusually wide range of climatic zones. Thus the country has a transition zone with high endemism values where the nearctic and neotropical regions meet. North of this region is a high plateau, much of which is semiarid desert, with lowlands and tropical

rainforests to the south. Mexico also has an extensive coastline, being bordered in the west by the Pacific Ocean and on the east by the Gulf of Mexico and the Caribbean Sea. Politically the country is divided into 32 states. Because of the varied climate and resulting ecological zones, Mexico is considered one of the five most biologically diverse countries in the world (Mittermeier, 1988). The subtropical and tropical zones in the southern part of the country possess an ideal climate for the growth of fungi.

Materials and methods: Over a period of several years the mycological literature, including the major journals, was searched for reports of ascomycetes from Mexico. Of particular value in this regard were the local journals *Boletín de la Sociedad Mexicana de Micología*, the *Revista Mexicana de Micología*, and the *Acta Mexicana de Botánica*. The resulting records obtained in this search were analyzed for frequency of occurrence and distribution. Although every effort has been made to include all ascomycetes from Mexico, it is likely that some records were missed, especially from the earlier literature.

Results: The first reports of ascomycetes from Mexico appear to be those of Fries (1851), who described six species from the state of Veracruz, and of Berkeley (1867), who described two species. During the ensuing 150+ years many additional species have been discovered, most of them within the past 40 years. Numerous individuals have contributed to these reports, in particular, Gastón Guzmán, Evangelina Pérez-

Silva and their collaborators, Santiago Chacón, Rosario Medel and Felipe San Martín. A complete list of these reports is beyond the scope of this article, but most are included in the papers listed at the end of this paper.

The first list of fungi from Mexico was by Zenteno Zevada et al. (1955), which included 18 ascomycetes. Most were plant pathogenic fungi, reflecting the interests of the senior author. The ascomycetes received scant attention before the 1960's. Heim and Herrera (1961) listed an ascomycete record from Mexico and Welden and Lemke (1961) also included ascomycete records. Gómez and Herrera (1966) studied the systematics, histology and ecology of the genus *Helvella* L.. This was followed by lists of fungi from the regions of Uxpanapa, Coatzacoalcos, Los Tuxtlas, Papaloapan and Xalapa (Welden and Guzmán, 1978; Welden et al., 1979). Some Mexican lichen studies are those of Welden and Guzmán (1978), Welden et al. (1979) and Álvarez and Guzmán-Dávalos (1988). Studies of ascomycetous yeasts are scarce; Herrera et al. (1973) described a new species of *Hansenula* Syd. & P. Syd. Marine ascomycetes from Mexico were listed by González et al. (2001). Subsequent partial lists of ascomycetes have been published by Chacón and Medel (1988) and Medel and Chacón. (1988, 1992, 1997).

Ascomycetes have been reported from all 32 states in the country, with the most abundant collections from the states of Chiapas, Mexico, Oaxaca and Veracruz. These states are closest to the largest concentrations of mycologists in the country at the Institute of Biology in Xalapa and at the University of Mexico in Mexico City, both of which are located in the south-central part of the country. Relatively few collections have been made in the northernmost states, with the fewest collections from the states of Nayarit and Aquascalientes and the Peninsula of Baja California (Figure 1).

A review of these papers reveals that the majority of ascomycetes reported from Mexico thus far are macroascomycetes, i.e., species with ascospores large enough to be readily seen by casual observation. Many of the microascomycetes reported are plant pathogenic species encountered in the course of studies on diseases of economically important crop plants (Montes, 1992). Exceptions to this are the entomogenous genus *Laboulbenia*, and the coprophilous genera *Podospora* and *Sporormiella*, resulting from the works of Thaxter (1893, 1905, 1914) and of Ahmed and Cain (1972), respectively.

The Xylariaceae is the most intensively studied family of ascomycetes, due primarily to the efforts of Pérez-Silva (1972, 1973, 1975, 1983) and San Martín and Lavin (1997, 1999), San Martín and Rogers (1993a,b; 1995a,b), San Martín et al., (1997, 1998a,b 1999, 2001) and Medel et al. (1989, 2006). The ten most commonly encountered genera of ascomycetes are *Xylaria* Hill ex Schrank, with 100 species, followed by *Hypoxylon* Bull. with 48. These are followed by *Parmotrema* A. Massal. (36), *Laboulbenia* Mont. & C.P. Robin (32), *Cladonia* P. Browne (30), *Podospora* Ces. (29), *Heterodermia* Teevis. (27), *Meliola* Fr. (22), *Sporormiella* Ellis & Everh. (21) and *Hypotrachyna* (Vain.) Hale (21). Among the discomycetes, *Peziza* Dill. ex Fr. is most common with 14 species and *Morchella* Dill. ex Pers. with 13.

Discussion: The purpose of this paper is to present an analysis of all teleomorphic ascomycetes reported from Mexico, and to compare these data with data in Kirk et al. (2001). The present compilation includes 1,331 species + 24 varieties of ascomycetes, for a total of 1,355 identified taxa. In an additional 27 reports the fungus is identified only to genus and

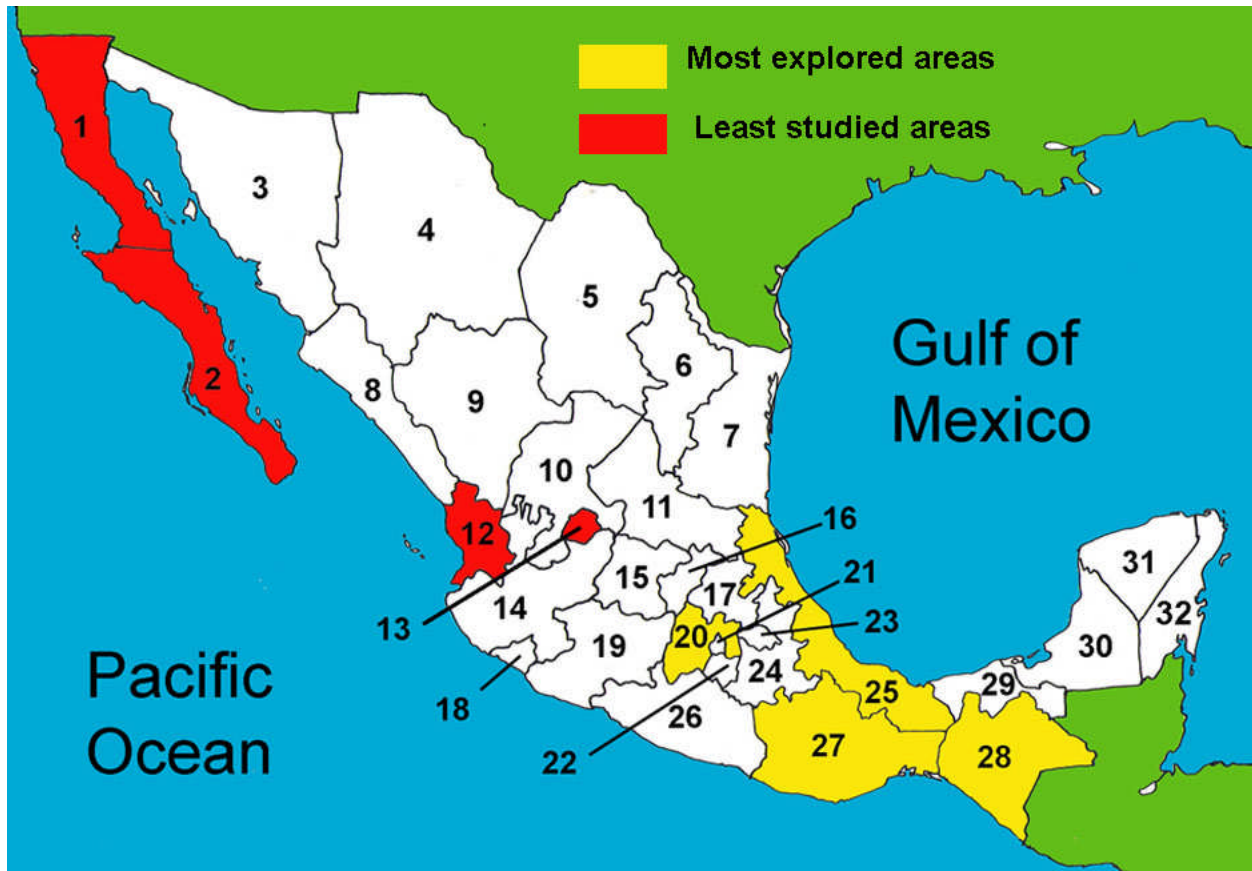


Fig. 1. Political map of Mexico showing regions of greatest and fewest collections of ascomycetes. States of Mexico. 1. Baja California Norte. 2. Baja California Sur. 3. Sonora. 4. Chihuahua. 5. Coahuila. 6. Nuevo León. 7. Tamaulipas. 8. Sinaloa. 9. Durango. 10. Zacatecas. 11. San Luis Potosí. 12. Nayarit. 13. Aguascalientes. 14. Jalisco. 15. Guanajuato. 16. Querétaro. 17. Hidalgo. 18. Colima. 19. Michoacán. 20. Estado de México. 21. Tlaxcala. 22. Guerrero. 23. Distrito Federal. 24. Morelos. 25. Puebla. 26. Oaxaca. 27. Veracruz. 28. Chiapas. 29. Tabasco. 30. Campeche. 31. Yucatán. 32. Quintana Roo.

seven of these have no identified species. Approximately 35% of these ascomycetes are lichenized. These species are distributed among 414 genera in 41 orders and 126 families, with a few taxa listed as *Incertae sedis*. The precise number of species is difficult to ascertain due to nomenclatural changes and the imprecision of species identification in the ascomycetes. The preparation of a comprehensive list of Mexican ascomycetes is planned and the intention is to make this list available on the internet in the future so that it will be readily accessible and easy to update.

Kirk et al. (2001) accepted 32,739 species of ascomycetes worldwide: the 1,355 species identified in Mexico thus far represent 4.1% of this number. Of these, 4.9% are from freshwater and marine environments. Hawksworth (1991) proposed that there could be as many as 1.7 million species of fungi in the world. He based this number on extrapolations of plant-fungus associations discovered in intensively studied areas in England. Using a similar procedure, Guzmán (1998) estimated that perhaps 200,000 species of fungi occur in Mexico. Inasmuch as 60% of the fungal species described worldwide

are ascomycetes, this would indicate that 120,000 of these should be ascomycetes. If accurate, only 1.15% of them have been discovered in the country thus far. Clearly, there is a need for much more alpha taxonomy in Mexico.

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