



Diversity and distribution of mosses in the state of Hidalgo, Mexico

Diversidad y distribución de musgos en el estado de Hidalgo, México

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Abstract. Through field work, bibliographic information and herbarium collections, a preliminary list of mosses for the state of Hidalgo was compiled. Records for 355 species were supported by 3 068 herbarium specimens at MEXU; when varieties are included along with taxa unsupported by local herbarium specimens, the number of taxa reaches 420. A collecting effort analysis indicates that 74.5% of the moss flora has been surveyed, that is, 56 taxa remain to be added. Species distribution modeling using 20 climatic variables from the WorldClim database for 150 species produced a map of potential distribution using a 5-minute cell network; it shows that the species potential richness is higher in central and southeastern Hidalgo, although most collections were obtained in southern and northwestern stations. Because large portions of the state land area are underexplored for mosses, no biodiversity hotspots are recognized. The Caribbean element is best represented in the Eastern Sierra Madre, but the confluence of the latter with the Neovolcanic Belt does not seem to show other major floristic differences between them, despite their geographical proximity.

Key words: richness patterns, collecting effort, potential distribution, Maxent.

Resumen. Se presenta una lista preliminar de musgos del estado de Hidalgo basada en trabajo de campo, bibliografía y colecciones de herbario. Con base en 3 068 ejemplares en MEXU se registran 355 especies, pero esta cifra se incrementa a 420 si se incluyen las variedades y los taxa sin registros en los herbarios locales. El análisis del esfuerzo de recolecta señala que se ha registrado el 74.5% de la riqueza estatal, es decir, 56 taxa menos del valor esperado. Los modelos de distribución potencial de 150 especies, usando 20 variables climáticas de la base de datos de WorldClim y una división en celdas de 5 minutos, indica que la riqueza potencial de musgos es más alta en el centro y sureste del estado, a pesar de que la mayoría de las colecciones provienen de sitios del sur y noroeste. Como partes importantes del centro del estado todavía están poco exploradas, no se reconocen zonas de alta diversidad. No se han detectado diferencias en patrones florísticos, excepto en el elemento del Caribe que está mejor representado en la sierra Madre Oriental que en el Eje Neovolcánico, a pesar de la cercanía geográfica de las 2 áreas.

Palabras clave: patrones de riqueza, esfuerzo de colecta, distribución potencial, Maxent.

Introduction

Mosses of the state of Hidalgo have been collected and studied since the beginning of the XX century. Among the early collections are those obtained by Cyrus G. Pringle through several visits to the state (Davis, 1936). His moss collections were sent to J. Cardot (1909, 1910, 1911) for identification. In mid-XX century, Crum (1951) cited specimens by various collectors, including A. J. Sharp and his collaborators, referring to them by collector name and number; most of these specimens were deposited in MICH and other American herbaria. Sharp et al. (1994) included 281 moss taxa for Hidalgo, but the Moss Flora

of Mexico did not cite specimens. In recent years, Alfaro and Castillo (1986) listed 169 species and varieties for Sierra de Pachuca; Cárdenas and Delgadillo (2009) cited specimens from localities bordering the Valley of Mexico that politically belong in Hidalgo; Delgadillo et al. (2011) listed 129 species and varieties from Los Mármoles National Park. The specimens derived from the last 3 contributions were deposited in the Bryophyte Collection at the National Herbarium (MEXU).

Despite the floristic information available, it seems that many areas in Hidalgo have not been explored for mosses, some sites are represented by many collections, and that a broader selection of sites should provide an adequate representation of the state's moss flora. Because of its geological and geographical setting, especially at the point of contact between the Eastern Sierra Madre (ESM)

and the Neovolcanic Belt (NVB), collections in the state of Hidalgo along with other nearby areas may be informative of the history of moss migration in this part of Mexico. In this contribution we offer a preliminary assessment of actual and potential species richness, and patterns of distribution; these may be in order to plan future field work in various parts of the state.

The state of Hidalgo in eastern Mexico has a surface area of nearly 21 000 km² (García and Falcón, 1984). Its rugged relief is dominated by the Eastern Sierra Madre that runs NW-SE; numerous sierras and isolated mountains are found in southern and western areas, several of them reaching more than 3 000 m in elevation (cf. INFDM, 2005). Because of its geographical position, the state is also part of the Neovolcanic Belt area.

Materials and methods

Recently collected specimens and samples deposited in MEXU were examined along with records from the literature to produce a list of moss species from the state of Hidalgo. Major literature sources of floristic and geographical information were the updated electronic version of LATMOSS 2010 (Delgadillo, 2010) and Sharp et al. (1994) that complemented specimen data. The information for 3 068 moss specimens was compiled in a georeferenced database with records for 355 species that served to calculate cell width of the area of occupancy (AOO), according to IUCN criteria (IUCN, 2001). In this

study, cell size is the longest axis between 2 collecting points divided by 10; the size of the grids (area of occupancy) was calculated by using the Conservation Assessment Tools designed for Arcview (Moat, 2007). The species cell width was averaged to obtain the width value applicable to all species; the value thus obtained, 8.4 km, was transformed to arc minutes (about 5 minutes). For further analysis, the state of Hidalgo was then divided into a network of 5-minute cells.

Collecting effort. The geographical data of the collecting records were used to produce a species accumulation curve (Gotelli and Colwell, 2001). Seventy-seven 5-minute cells with collecting records were used for the analysis. The asymptote of the accumulation curve (Fig. 1) is theoretically related to the number of species expected for the study area (Jiménez-Valverde and Hortal, 2003) and the number of cells is a measure of the collecting effort after randomly sorting these 50 times to produce a soft curve with EstimateS, version 8.2.0 (Colwell, 2009). The asymptote was estimated adjusting Clench's equation to the accumulation curve (Soberón and Llorente, 1993; Colwell and Coddington, 1994) by the Simplex and Quasi-Newton method in the STATISTICA software (StatSoft, 2011); the predicted asymptotic value was used to estimate the precision of the inventory.

Known species richness. The collecting data for 3 068 records were placed in the 5-minute cell network to identify the number of species per geographic unit and to produce a known species richness map (Fig. 2).

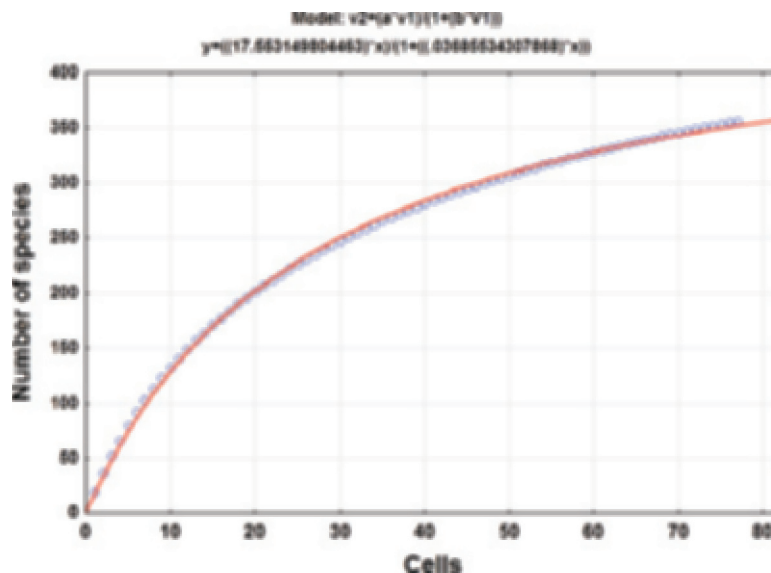


Figure 1. Accumulation curve for moss species in the state of Hidalgo. The circles represent sampling units (5 arc-minute longitude/latitude cells). Curve parameters are indicated in the equation on the upper end.

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