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A PRELIMINARY CHECKLIST OF THE MOSSES OF GUANAJUATO, MEXICO

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ABSTRACT

The Mexican state of Guanajuato was virtually unknown bryologically before this study was undertaken. To date, 114 moss species and subspecific taxa have been recorded, but this figure seems to be only a fraction of a formerly rich flora. Agriculture, mining, industry and other forms of alteration may have impoverished the state moss flora and continue to deplete its biomass and diversity. Similar situations are found throughout the American tropics and Guanajuato may be taken as a sample case to understand the effects of sustained environmental alteration in the highlands of Mexico and elsewhere. The floristic list includes two new records for Mexico: *Tortella fruchartii* (C.M.) Zand. and *Weissia rostellata* (Brid.) Lindb.

RESUMEN

El estado de Guanajuato era virtualmente desconocido desde el punto de vista briológico hasta antes de este estudio. A la fecha se han reconocido 114 especies y taxa subespecíficos de musgos, pero este número parece ser sólo una fracción de una flora previamente mucho más rica. La agricultura, la minería, la industria y otras

formas de alteración deben haberla empobrecido y continúan diezmando su biomasa y diversidad. Hay situaciones similares en el trópico americano, por lo que Guanajuato puede servir como caso de estudio para entender los efectos de la alteración ambiental sostenida en la Altiplanicie Mexicana y en otras partes. La lista de especies incluye dos registros nuevos para México: *Tortella fruchartii* (C.M.) Zand. y *Weissia rostellata* (Brid.) Lindb.

INTRODUCTION

It was stated elsewhere (Delgadillo, 1992) that Guanajuato is one of several Mexican states that are nearly unknown from the bryological point of view. To be sure, in addition to a specimen of *Braunia secunda* (Hook.) B.S.G. (Crum, 1951), moss records published for Guanajuato include *Fissidens crispus* Mont. and *Tortula fragilis* Tayl. (Sharp, Crum & Eckel, 1994) and others cited by Delgadillo (1987) in connection with phytogeographical research on the Neovolcanic Belt of central Mexico bringing to 20 the total number of moss species previously recognized for the state. The purpose of this report is, therefore, three-fold: provide a listing of local mosses, obtain distributional data for mosses in central Mexico, and produce a preliminary evaluation of species richness based on recent field work by the authors.

MOSSES OF GUANAJUATO

The state of Guanajuato is located on the southern end of the Mexican Plateau in central Mexico. Its southern half is part of a lowland area locally known as the "Bajío", is generally below 2000 m in elevation, but spotted with mountains which in Sierra de los Agustinos -in the southeastern corner of the state- reach 3110 m in elevation (Rzedowski & Calderón, 1987). The northern half is a mountain area with an altitude frequently above 2000 m (cf. García & Falcón, 1984).

Preliminary exploration was conducted throughout the state covering major vegetational types (except the pine forest), at various altitudes. The date, collection numbers, localities and general description of the vegetation are given below.

June 3, 1986

Delgadillo 4916-4927, Cárdenas 4430-4439. 8 km SE de Acámbaro, 20° 03'N - 100° 37'W. Pastizal con leguminosas, cactáceas candelabroiformes, *Bursera*, *Opuntia* y *Ceiba* (?).

Delgadillo 4928-4930. Agua Caliente, 6 km SE de Acámbaro, 20° 04'N - 100° 39'W.

June 5, 1986

Delgadillo 4961-4968, Cárdenas 4461-4467. 5 km SW de Acámbaro, 20° 01'N - 100° 43'W. Matorral con *Bursera*, *Erythrina*, *Euphorbia* y leguminosas, en el fondo de una cañada.

November 11, 1992

Delgadillo 5671-5682, Cárdenas 5227-5242. Elevaciones al SW de Guanajuato, Gto., 21° 01'N - 101° 16'W. Matorral perturbado, con *Ipomoea* y *Opuntia*.

November 12, 1992

Delgadillo 5683-5692, Cárdenas 5243-5250. 3 km E del Cerro del Cubilete, 20° 59'N - 101° 20'W. Bosque de *Quercus*.

Delgadillo 5693-5705, Cárdenas 5251-5261. 9 km NE de Guanajuato, Gto., 21° 04'N - 101° 11'W. Bosque de *Quercus*.

Cárdenas 5262-5270. Cerro de la Vigilancia, Guanajuato, Gto., 21° 02'N - 101° 14'W.

November 13, 1992

Delgadillo 5706-5710, Cárdenas 5271-5278. Abasolo, 20° 27'N - 101° 32'W. Bosque de *Quercus*.

Delgadillo 5711-5721, Cárdenas 5279-5287. 11 km NW de Pénjamo, 20° 27'N - 101° 46'W. Bosque de *Quercus* y campos de cultivo adyacentes, abandonados.

November 14, 1992

Delgadillo 5723-5731, Cárdenas 5288-5296. Cerro Gordo, al NW de León, 21° 07'N - 101° 40'W. Remanentes de Selva baja caducifolia.

Delgadillo 5733-5735, Cárdenas 5297. 55 km SW de San Felipe, 21° 18'N - 101° 20'W. Bosque de *Quercus*.

November 15, 1992

Delgadillo 5736-5741, Cárdenas 5298-5301. 9 km NW de San Miguel Allende, 20° 59'N - 100° 47'W. Matorral inducido, con *Opuntia* y *Mimosa*, acompañado de un pastizal.

Delgadillo 5742-5749, Cárdenas 5302-5305. 3 km S de San Luis de la Paz, 21° 17'N - 100° 31'W. Matorral con *Hechtia*, *Jatropha*, *Opuntia* y otras cactáceas.

November 16, 1992

Delgadillo 5750-5753, Cárdenas 5306-5316. 13 km NE de Guanajuato, Gto. 21° 05'N - 101° 10'W. Bosque de *Quercus*.

Delgadillo 5754-5765, Cárdenas 5317-5326. 4 km S de San José Iturbide, 20° 59'N - 100° 23'W. Bosque de *Quercus*.

October 27, 1993

Delgadillo 5766-5787, Cárdenas 5327-5344. 4 km S de San José Iturbide, 20° 59'N -100° 23'W. Bosque de *Quercus*.

October 28, 1993

Delgadillo 5788-5797, Cárdenas 5345-5356. Sierra de los Agustinos, 2 km NW de Piedras de Lumbre, municipio de Jerécuaro, 20° 17'N - 100° 36'W. Bosque de *Quercus* abierto.

October 29, 1993

Delgadillo 5798-5809, Cárdenas 5357-5366. Sierra de los Agustinos, 2 km E de Acebuche, al S de Tarimoro, 20° 14'N - 100° 44'W.

October 30, 1993

Delgadillo 5810-5817, Cárdenas 5367-5370. Sierra de Pénjamo, 6 km N de Tierras Negras, municipio de Pénjamo, 20° 32'N - 101° 47'W. Bosque de *Quercus* abierto.

Delgadillo 5818-5819, Cárdenas 5371: Sierra de Pénjamo, 2 km N de Tierras Negras, municipio de Pénjamo, 20° 31'N - 101° 46'W. Bosque de *Quercus* joven.

October 31, 1993

Delgadillo 5820-5821. Sierra de Pénjamo, 27 km SW de Cuerámaro, 20° 35'N - 101° 46'W. Remanentes de Bosque de *Quercus*.

Delgadillo 5822-5829, Cárdenas 5372-5382. Sierra de Pénjamo, 24 km SW de Cuerámaro, 20° 35'N - 101° 45'W. Bosque de *Quercus*.

Delgadillo 5830-5837, Cárdenas 5383-5389. Sierra de Pénjamo, 9 km SW de Cuerámaro, 20° 37'N - 101° 41'W. Arroyo en fondo de cañada, bordeado por *Taxodium*.

In the following list, names preceded by an asterisk (*) have been reported in the literature while the remaining are all new state records. Collection numbers follow the specific epithets; those belonging to A. Cárdenas are indicated by a "C". All specimens are deposited at MEXU with duplicates sent to other herbaria.

AMBLYSTEGIACEAE

Amblystegium serpens (Hedw.) B.S.G. var. *juratzkanum* (Schimp.) Rau & Herv., 5831b.

Drepanocladus aduncus (Hedw.) Warnst. var. *polycarpus* (Bland. ex Voit) Roth, C5388.

Leptodictyum humile (P. Beauv.) Ochyra, C5383c.

Leptodictyum cf. *riparium* (Hedw.) Warnst., 5830, C5384, C5389. The identification of these specimens is tentative. The leaves are ovate with a short broadly obtuse apex, but in consideration of the great variability exhibited by this species (Crum & Anderson, 1981), the specimens from Guanajuato are included here.

ANOMODONTACEAE

**Herpetineuron toccoae* (Sull. & Lesq.) Card., C4466.

ARCHIDIACEAE

Archidium donnellii Aust., 5686, 5705, 5766, 5797b, C5320a.

Archidium ohioense Schimp. ex C.M., 5812.

BARTRAMIACEAE

Anacolia laevisphaera (Turn.) Par., 5803, C5235.

Philonotis marchica (Hedw.) Brid., 5677.

Philonotis sphaericarpa (Hedw.) Brid., 5780.

Philonotis uncinata (Schwaegr.) Brid., 5835.

BRACHYTHECIACEAE

Brachythecium cf. *occidentale* (Hampe) Jaeg., 5834.

Brachythecium stereopoma (Spruce ex Mitt.) Jaeg., 5807, 5809.

BRYACEAE

Anomobryum filiforme (Dicks.) Solms ex Rabenh., 5768, C5317, C5352, C5364.

**Brachymenium mexicanum* Mont., 4967, 5752, 5798, 5827, C5277, C5360, C5373, C5380.

Brachymenium niveum Besch., 5813, C5376, C5377.

Brachymenium systylium (C.M.) Jaeg. & Sauerb., 5716, C5285, C5381.

Bryum argenteum Hedw., 5729b, C5245.

Bryum billardieri Schwaegr., 5687, 5753, 5800, 5822, C5248, C5313, C5350.

**Bryum chryseum* Mitt., 5678, C4431, C5323.

Bryum procerum Schimp. ex Besch., C5315.

Epipterygium immarginatum Mitt., 5783, C5339.

Pohlia elongata Hedw., 5785, 5794, 5799, C5239, C5330, C5346, C5363.

DICRANACEAE

Aongstroemia orientalis Mitt., 5793, C5266, C5356b, C5390a.

Campylopus fragilis (Brid.) B.S.G., 5679.

Campylopus nivalis (Brid.) Brid., 5694, C5349, C5357, C5371.

Campylopus pilifer Brid., C5275, C5322, C5345, C5348, C5354.

DITRICHACEAE

Ceratodon purpureus (Hedw.) Brid. ssp. *purpureus*, 5693, C5261.

Ceratodon purpureus (Hedw.) Brid. ssp. *stenocarpus* (B.S.G.) Dix., 5776, C5331.

Pleuridium subulatum (Hedw.) Rabenh., 5765b, C5255.

Pleuridium sullivantii Aust. var. *mexicanum* (Card.) Cárde., 5691, 5702, 5795, 5797a, 5818, C5297, C5326, C5390b.

ENTODONTACEAE

**Entodon beyrichii* (Schwaegr.) C.M., 4961, 5713, C5282, C5309, C5366.

Erythrodontium longisetum (Hook.) Par., C5254.

FABRONIACEAE

Anacamptodon compactus (Thér.) Buck, 5790. According to Buck (1994), the operculum and calyptra of this species are unknown. The specimen from Guanajuato is fruiting and shows several opercula and young sporophytes; the former are convex and beaked while the calyptra seems to be cucullate and smooth.

Fabronia ciliaris (Brid.) Brid. var. *ciliaris*, 5730c, C4437, C5295.
**Fabronia ciliaris* (Brid.) Brid. var. *wrightii* (Sull.) Buck, 4965, 5675, C5291, C5300.
**Fabronia ciliaris* (Brid.) Brid. var. *polycarpa* (Hook.) Buck, C4436.
Fabronia macroblepharis Schwaegr., 5684, C5362.

FISSIDENTACEAE

Fissidens asplenioides Hedw., 5782, C5340.
**Fissidens crispus* Mont., 4918, 5746, 5777, 5820, 5831a, C5283, C5292, C5328, C5374a, C5383a.
Fissidens michoacanus Thér., 5706.
Fissidens ramicola Broth., 5761.

FUNARIACEAE

Entosthodon obtusifolius Hook. f. in Hook., 5696, 5784, 5796, 5819.
Funaria hygrometrica Hedw. var. *hygrometrica*, 5676, 5729a, 5769, C5343.
Funaria hygrometrica Hedw. var. *calvescens* (Schwaegr.) Mont., C5374b.

GRIMMIACEAE

Grimmia affinis Hoppe & Hornsch., 5751.
**Grimmia arizonae* Ren. & Card., 4968, 5681.
Grimmia ovalis (Hedw.) Lindb., 5755, 5824, C5269, C5337, C5344.
Grimmia pulla Card., 5829.

HEDWIGIACEAE

**Braunia secunda* (Hook.) B.S.G., 5698, C4461, C5312, C5351.
Hedwigia ciliata (Hedw.) P. Beauv., C5310, C5361.
Hedwigidium integrifolium (P. Beauv.) Dix. ex Jens., 5750.

HYPNACEAE

Homomallium mexicanum Card., 5825.
Platygyriella densa (Hook.) Buck, 5823, 5828a, C5276.

Platygyriella pringlei (Card.) Buck, 5772, 5828b, C5358, C5378, C5382.
Pylaisiella falcata (B.S.G.) Ando, 5704, C5258, C5316.
Taxiphyllum taxirameum (Mitt.) Fleisch., 5833.

LESKEACEAE

Haplocladium angustifolium (Hampe & C.M. in C.M.) Wat. & Iwats., 5695, 5700, C5250, C5270.
Haplocladium virginianum (Brid.) Broth., 5778. Besch. (1872) listed *Thuidium virginianum* Sch. from Mexico, but Cardot (1911) referred this record to *Haplocladium microphyllum* (Hedw.) Broth. William R. Buck, in examining a duplicate, commented on the reduced number of paraphyllia on stem and branches of the Guanajuato specimen, but concluded that it belongs in *H. virginianum*. The study of other Mexican specimens will be necessary to determine the range and variation of the species in Mexico and whether these variations may be considered as part of the species concept.
Leskea angustata Tayl., 5727, C5284a, C5311.
Lindbergia mexicana (Besch.) Card., 5725, 5837, C5319, C5333, C5347, C5367.
Lindbergia ovata Thér., 5810. This species is known from Michoacán (Thériot, 1928) and Zacatecas; from the latter state it was reported as *L. brachyptera* (Mitt.) Kindb. (Cárdenas & Delgadillo, 1984; Sharp, Crum & Eckel, 1994), but further analysis of the specimens revealed that they were misidentified and that *L. brachyptera* is yet to be found in Mexico.

ORTHOTRICHACEAE

Macrocoma tenue (Hook. & Grev.) Vitt ssp. *sullivantii* (C.M.) Vitt, C5262a.
Orthotrichum bartramii Will., 5683a, 5685b.
Orthotrichum diaphanum Brid., 5683b, 5742a, 5811.
Orthotrichum pycnophyllum Schimp. ex C.M., 5703, 5719, 5814a, C5314.
Zygodon ehrenbergii C.M., C5262b, C5267.
Zygodon obtusifolius Hook., C5308.

POLYTRICHACEAE

Atrichum muelleri Schimp. ex Besch., 5775, C5341, C5359.
Pogonatum campylocarpum (C.M.) Mitt., 5734, 5786, 5788, 5802, C5251, C5264, C5353.

Pogonatum oligodus (C.M.) Mitt., 5779, C5259, C5321.

POTTIACEAE

Acaulon muticum (Hedw.) C.M. var. *rufescens* (Jaeg.) Crum, C5246.

Aloina hamulus (C.M.) Broth., 5692a, 5737, C5298, C5304.

**Anoectangium aestivum* (Hedw.) Mitt., 5673, C4464.

**Barbula spiralis* Schimp. ex C.M., 4917, 5744b, 5770b, C5324, C5303.

Bryoerythrophyllum campylocarpum (C.M.) Crum, 5701, 5774, 5789b, C5332, C5334, C5335, C5338.

**Bryoerythrophyllum inaequalifolium* (Tayl.) Zand., 4964, 5682, C5260, C5318b.

Bryoerythrophyllum recurvirostrum (Hedw.) Chen, 5689.

Bryoerythrophyllum recurvirostrum (Hedw.) Chen var. *aeneum* (C.M.) Zand., C5318a.

Desmatodon convolutus (Brid.) Grout, 5692c, 5744a, C5305a.

**Didymodon australasiae* (Hook. & Grev.) Zand. var. *australasiae*, 4925, 5707, 5836, C4435, C5305b.

Didymodon australasiae (Hook. & Grev.) Zand. var. *umbrosus* (C.M.) Zand., C5383b, C5385b.

**Didymodon incrassatolimbatus* Card., 4927, 4963, C4432, C4438.

**Didymodon revolutus* (Card.) Will., 4928, 5745, 5770a.

**Didymodon rigidulus* Hedw., 4919, C5273.

**Didymodon rigidulus* Hedw. var. *gracilis* (Schleich. ex Hook. & Grev.) Zand., 4930, 5709, 5826, 5832, C5385a.

Didymodon rigidulus Hedw. var. *icmadophila* (Schimp. ex C.M.) Zand., 5688.

Gymnostomum aeruginosum Sm., 5792.

Leptodontium flexifolium (Dicks. ex With.) Hampe ex Lindb., 5710, C5274.

Leptodontium brachyphyllum Broth. & Thér., 5699.

Molendoa sendtneriana (B.S.G.) Limpr., 5674, C5231.

Morinia stenothea (Thér.) Zand., C5268.

Oxystegus tenuirostris (Hook. & Tayl.) A.J.E. Smith, 5764.

Rhexophyllum subnigrum (Hedw.) Hilp., 5697, 5804, C5262c, C5306.

Scopelophila norrisii Zand., 5708, C5278.

Tortella fruchartii (C.M.) Zand., 5711. New to Mexico. Formerly known from Paraguay as *Astomum fruchartii* (C.M.) Broth.; the taxonomic position of this species was recently revised by Zander (1993), who suggested that it may be conspecific with *T. lilliputana* (C.M. ex Roth) Zand. from Panama and Brazil.

Tortula amphidiacea (C.M.) Broth., 5730a, 5801, 5814b, C5280a, C5294.

Tortula aurea Bartr., 5738, C5302b.
 **Tortula fragilis* Tayl., 4923, 5714, C5280b, C5288, C5342, C5365, C5368, C5379, C5386.
 **Tortula heteroloma* Card., 4922.
Tortula obtusissima (C.M.) Mitt., 5739, C5293.
Tortula pagorum (Milde) De Not., 5728, 5741, C5301.
 **Trichostomum brachydontium* Bruch, 4920, 4921, C4430, C5256, C5329a, C5369.
Weissia andersoniana Zand., 5767, 5771, 5789a, C5327, C5329b.
Weissia andrewsii Bartr., 5773, 5791.
Weissia condensa (Voit.) Lindb., 5821, C5325.
Weissia controversa Hedw., 5671, 5765a, C5227, C5249.
Weissia jamaicensis (Mitt.) Grout, 5748.
Weissia rostellata (Brid.) Lindb., 5757, 5759. New to Mexico. Juárez and Sharp (1976) reported *W. rostellata* var. *phascooides* (Hook. ex Drumm.) Reese & Lemmon from material collected in Veracruz, but Zander (1985) stated that the specimen belongs to *W. semidiaphana* (Thér.) Zand. Comparison with reliable specimens from other herbaria has not been possible.
Weissia semidiaphana (Thér.) Zand., 5815, C5370, C5372.
Weisiopsis oblonga Thér., 5680.

RACOPILACEAE

Racopilum tomentosum (Hedw.) Brid., 5805, 5808.

SEMATOPHYLLACEAE

Sematophyllum galipense (C.M.) Mitt., C5252, C5355.

THUIDIACEAE

Thuidium delicatulum (Hedw.) B.S.G. var. *radicans* (Kindb.) Crum, Steere & Anderson, C5265.

DISCUSSION

The list contains names for taxa in 22 families, 62 genera and 114 species and varieties. Several families are important in terms of the number of species, notably,

the Bryaceae, Fabroniaceae, Leskeaceae, Orthotrichaceae and Pottiaceae. The last taxon includes about 40 species that account for 35 per cent of the local flora, with *Didymodon*, *Tortula* and *Weissia* as the most numerous. Among the mosses in this flora, adaptations to peculiar habitats can be observed; the ephemeral cleistocarpic species are infrequent, but are represented by *Acaulon muticum* var. *rufescens*, *Archidium donnellii*, *A. ohioense*, *Pleuridium subulatum*, *P. sullivantii* var. *mexicanum*, *Tortella fruchartii* and *Weissia rostellata*. This moss flora is usually found in dry habitats, but at least one species has been observed in subaquatic conditions, *Leptodictium riparium*. Although the forests are and have been under continued pressure and most mosses grow on soil, there are many epiphytic species and several are common on rocks.

The flora includes taxa that are widely distributed in Mexico and elsewhere in the world, for instance, *Bryum argenteum*, *B. chryseum*, *Ceratodon purpureus*, *Didymodon australasiae*, *Funaria hygrometrica* and *Weissia controversa*. These are common in disturbed areas and are frequently considered as weedy species and, thus, their presence in Guanajuato is not wholly unexpected. The Pottiaceae, on the other hand, may have become widespread there because they are well adapted to disturbance (Zander, 1993).

Moss diversity in Guanajuato is below that of other Mexican states with equivalent or smaller land surface. To be sure, according to data in Sharp, Crum and Eckel (1994), mosses reported for the states of Mexico are 253, Distrito Federal 171, Hidalgo 280 and Morelos 119; among the neighboring states with a larger land surface Jalisco has 215 moss species, San Luis Potosí 208 and Michoacán 230. It must be pointed out that the difference in floristic richness between Guanajuato and other states may be partly due to different collecting histories; also, that these are preliminary data that only reflect the number of specimens available for study. The size of the known moss flora of each state may increase with input of information from herbaria and from the literature as, for instance, in the case of Zacatecas for which Sharp, Crum and Eckel (1994) listed only 48 moss species while Delgadillo and Cárdenas (1987) recorded 115.

Because there are no previous listings of the mosses for any area of Guanajuato, it cannot be established with certainty whether the number of species has varied through time or with reduced forest size. However, field observations by the authors and by others seem to confirm that significant floristic changes have occurred in Guanajuato. Its lowland area has been the site of intensive agriculture; these practices are being extended to and are now evident in the upper elevations throughout the state; the land unsuitable for cultivation is left to grazing by cattle and goats. Furthermore, recent industrial development has brought about the establishment of numerous factories and the growth of cities since the 1950's; the original cover in the lowland area has been reduced by 95% and the tropical deciduous forest has been replaced by scrubby vegetation, for the most part (Rzedowski & Calderón, 1987). In the mountain

region of the state, disturbance goes as far back as the mid XVI century when mining flourished in the area. This activity produced heavy deforestation that continues around the city of Guanajuato, where several mines are still in operation. The oak forests prevalent in the northern mountain area are perhaps all secondary growth; signs of disturbance (fire and grazing) abound there and indicate that they have not been allowed to recover. The forests in the upper elevations of southern Guanajuato have been heavily cut and may have resulted in oak forests which, due to continued disturbance, are rather open; pine forests may still grow in the higher parts of Sierra de los Agustinos, but were inaccessible during fieldwork for this study.

Habitat destruction and pollution are factors that promote species disappearance in bryophytes and these are widespread around the state. Because of habitat fragmentation and the changes in the plant cover introduced by recent industrial growth and population encroachment as well as other forms of induced environmental alteration, it is suggested here that the moss flora of Guanajuato has declined in number of taxa. Comparison of the number of species for several states (see above) suggests that, with 114 known taxa, the moss flora of Guanajuato may indeed be depauperate or impoverished. Certain such areas as the lowlands may never have had a rich moss flora because of its generally dry climate, but continued human activity may have altered the number of taxa and the biomass that most species exhibit in the field.

If this view is correct, the state of Guanajuato may be taken as a clear illustration of the magnitude of human interference with natural ecosystems in the tropics. Mosses may have responded in various ways; in addition to the presumed extinction, the weedy species have become widespread; the cleistocarpic species became frequent and well developed in the old fields; species known elsewhere in less disturbed vegetation have reduced stature or biomass in the oak forests of Guanajuato, except for such species as *Braunia secunda*, *Orthotrichum* spp. and *Pogonatum* spp., which seem to find suitable substrates there; *Leptodontium* spp., *Macrocoma tenue*, *Pylaisiella falcata* and *Zygodon obtusifolius* are rather infrequent in the same forests. The epiphytic taxa such as *Fabronia ciliaris*, *Leskea angustata* and *Tortula amphidiecea* are still well represented in open forests or in the remainings of the tropical deciduous forest.

There is no evidence indicating the presence of an edge effect in the forest ecosystems of Guanajuato, i.e., of the presence of newly introduced ecologically tolerant species along the areas of contact between forest and open vegetation, as a response to continuous fragmentation of the forest. The large proportion of soil inhabitants is, perhaps, a measure of the widespread disturbance within and without the forest; there may have been few introductions as evidenced by the presence of *Astomum fruchartii* and *Weissia rostellata*, but we have not detected substantial numbers of species in any given area, as would be predicted by the edge effect hypothesis. To be sure, most species are part of a generalized flora occurring along the Neovolcanic Belt. On the other hand, the reduced number of infrageneric taxa and

the sustained alteration of habitats also argue against this hypothesis. Newton (1995) suggests that the dissection of tropical forests threatens the habitats of bryophytes and that the composition of epiphytic populations changes as the forest fragments shrink.

Forest disappearance is naturally followed by the elimination of most moss inhabitants, but forest fragmentation and continued disturbance may lead to forest impoverishment. Terborgh (1992) stated that species loss accompanies or quickly follows habitat fragmentation and that, at least for islands at equilibrium, the species number is halved for each reduction in area of 90 percent. According to the same author, fragmentation disrupts migration and dispersal patterns, reduces population and gene pool sizes and allows the development of edges that modify the physical microenvironment. All these effects are certainly in operation in areas of Guanajuato, where there is some forest left, but we need the field data to quantify and confirm the response of moss species to continued environmental alteration. Guanajuato may be used to illustrate the effects of disturbance in similar habitats in the highlands of Mexico or in other areas of the American tropics.

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LITERATURE CITED

- Buck, W. R. 1994. Fabroniaceae. In: Sharp, A. J., H. Crum. & P. M. Eckel. (eds.). The moss flora of Mexico. Mem. New York Bot. Gard. 69: 860-867.
- Bescherelle, E. 1872. Prodrômus Bryologiae Mexicanae ou énumération des mousses du Mexique avec description des espèces nouvelles. Mém. Soc. Sci. Nat. Cherbourg 16: 145-256.
- Cárdenas S., M. A. & C. Delgadillo M. 1984. Musgos de Zacatecas, México. II. Bol. Soc. Bot. Méx. 46: 13-18.
- Cardot, J. 1911. Coup d'oeil sur la flore bryologique du Mexique. Rev. Bryol. 38: 97-105.
- Crum, H. A. 1951. The Appalachian-Ozarkian element in the moss flora of Mexico with a check list of all known Mexican mosses. Ph.D. Dissertation. Univ. Michigan. Ann Arbor.

- Crum, H. A. & L. E. Anderson. 1981. Mosses of eastern North America. Columbia Univ. Press. Nueva York. Vol. 2.
- Delgadillo M., C. 1987. Floristic corridors for moss distribution across the Neovolcanic Belt of Mexico. I. The Tuxpan corridor. Jour. Bryol. 15: 165-175.
- Delgadillo M., C. 1992. Los musgos y la fitogeografía de México. Ciencias, No. especial 6: 35-40.
- Delgadillo M., C. & A. Cárdenas S. 1987. Musgos de Zacatecas, México III. Síntesis y fitogeografía. Bol. Soc. Bot. Méx. 47: 13-24.
- García de M., E. & Z. Falcón de G. 1984. Nuevo atlas Porrúa de la República Mexicana. Ed. Porrúa. México, D.F. 219 pp.
- Juárez G., L. G. & A. J. Sharp. 1976. *Weissia rostellata* var. *phascooides* new to Mexico. Bryologist 79: 384.
- Newton, A. E. 1995. A comparison of the species composition of bryophyte populations on forest and pasture trees at La Selva, Costa Rica. In: Delgadillo M., C. (ed.). International Bryological Conference. Tropical Bryophytes: Biology, Diversity and Conservation. Scientific Program, Abstracts, Field trips, Tourist tips. Instituto de Biología, UNAM - International Association of Bryologists. México, D.F.
- Rzedowski, J. & G. Calderón de R. 1987. El bosque tropical caducifolio de la región mexicana del Bajío. Trace 12: 12-21.
- Sharp, A. J., H. Crum & P. M. Eckel. (eds.). 1994. The moss flora of Mexico. Mem. New York Bot. Gard. 69: 1-1113 + i-xvii.
- Terborgh, J. 1992. Maintenance of diversity in tropical forests. Biotropica 24: 283-292.
- Thériot, I. 1928. Mexican mosses collected by Brother Arsène Brouard - II. Smithsonian Misc. Coll. 81: 1-26.
- Zander, R. H. 1985. Nomenclatural transfers in *Weissia* (Pottiaceae, Musci). Monogr. Syst. Bot. Missouri Bot. Gard. 11: 195-197.
- Zander, R. H. 1993. Genera of the Pottiaceae: Mosses of harsh environments. Bull. Buffalo Soc. Nat. Sci. 32: 1-378.