Scientific note

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Grimmia (Grimmiaceae, Bryophyta) in southern Mexico (Oaxaca and Chiapas)

Grimmia (Grimmiaceae, Bryophyta) en el sur de México (Oaxaca y Chiapas)

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Abstract:

Background and Aims: The taxonomy and distribution of *Grimmia* are well known because of recent reviews in global, continental, and regional studies. However, collections from some areas like southern Mexico are scarce. This study updates the distribution of *Grimmia* in southern Mexico and attempts to revise the hypothesis of its geographical distribution.

Methods: Field work in Oaxaca and Chiapas complemented records in a Neotropical database of *Grimmia*. Collections from these states partly validated models of potential distribution for several species prepared in a previous study.

Key results: There are three species of *Grimmia* in southern Mexico: *G. longirostris, G. pilifera*, and *G. trichophylla.* The last species is the only record for Chiapas where it is associated with other temperate and subtropical mosses.

Conclusions: Its known range in Mexico, as supported by the study of more than 900 specimens from this country, suggests that *Grimmia* arrived from North America, not from a southern origin because key species have not been found in Oaxaca and Chiapas.

Key words: Cerro Mozotal, geographical distribution, grimmias, mosses.

Resumen:

Antecedentes y Objetivos: Revisiones taxonómicas a nivel mundial, continental y regional han permitido un buen conocimiento de la taxonomía y distribución geográfica de *Grimmia.* Sin embargo, las colecciones para ciertas áreas como el sur de México son escasas. Este estudio actualiza la distribución del género en el sur de México e intenta revisar la hipótesis de su origen geográfico.

Métodos: Trabajos de campo en Oaxaca y Chiapas complementan los registros de una base de datos neotropicales para *Grimmia*. Las colecciones de estos estados validan parcialmente los modelos de distribución potencial preparados en un estudio previo.

Resultados clave: Se encontraron tres especies de *Grimmia* en el sur de México: *G. longirostris, G. pilifera* y *G. trichophylla.* Esta última es la única especie registrada para Chiapas en donde se asocia con otros musgos templados y subtropicales.

Conclusiones: Su área de distribución conocida en México, apoyada por la revisión de más de 900 ejemplares, sugiere que *Grimmia* llegó de Norteamérica y no de localidades del sur porque otras especies importantes no se han encontrado en Oaxaca y Chiapas.

Palabras clave: Cerro Mozotal, distribución geográfica, grimmias, musgos.

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Introduction

The geographical distribution of most species of *Grimmia* Hedw. (Grimmiaceae, Bryophyta) in the New World is well known due to field work and taxonomic revisions at continental and global scales (Greven, 1999, 2003; Muñoz, 1999; Muñoz and Pando, 2000; Delgadillo, 2015). However, despite this upgraded information, there are still questions on the origin of the discontinuous range of various species. Most of the 26 species recognized for the Neotropics are unknown from the area between central Mexico and northern South America (e.g., *Grimmia donniana* Sm. and *G. fuscolutea* Hook.). This geographical discontinuity is even larger for those species that occur in northern Mexico and northern/southern South America (*G. anodon* Bruch & Schimp., *G. laevigata* (Brid.) Brid., and *G. pulvinata* (Hedw.) Sm.). Their apparent absence in southern Mexico and Central America may be due to a deficient collection record or to the lack of suitable habitats. At least six species are known from Central America (Muñoz and Allen, 2002; Delgadillo, 2015).

Models of potential distribution for *Grimmia* indicated that some species were expected to occur in southern Mexico (Delgadillo et al., 2012), but only *G. longirostris* Hook., *G. pilifera* P. Beauv., and *G. trichophylla* Grev. have been recorded for this area. The study of more than 900 specimens from Mexico (Delgadillo, 2015) showed that the Neovolcanic Belt is the southernmost limit for most Mexican species of *Grimmia*, suggesting that the genus and its alpine species reached the Neovolcanic Belt area by migration from North America (Delgadillo, 1987). Hypothetically, the discovery of other species in the highlands of Oaxaca, and in central or southern Chiapas would suggest an alternate southern origin of *Grimmia* in Mexico. This contribution reports on recent field exploration in Oaxaca and Chiapas, updates the geographical distribution of the genus and the species in southern Mexico, and evaluates the hypothesis of its geographical derivation.

Materials and Methods

Field work was conducted in the highlands of Oaxaca and Chiapas in 2013, 2015 and 2018. Emphasis was placed on the search of *Grimmia* to validate previous models (Delgadillo et al., 2012) and offer support to an alternate hypothesis regarding a southern origin of Mexican species. Records of the specimens collected were added to a database originally prepared for a revision of the genus in the Neotropics (Delgadillo, 2015). Localities visited for *Grimmia* are given in Table 1 along with a summary of identified specimens; the latter were deposited in the Bryophyte Collection at MEXU. Identification of specimens was made using the keys and descriptions of publications cited in the introduction.

Results

According to our *Grimmia* database, the species are frequent in alpine grasslands, coniferous or *Quercus* forests. It is a group of high elevation elements representing a broad spectrum of environmental conditions present in xerophytic scrubby vegetation, dry pinyon pine forests, pine-oak-juniper woodlands, tropical deciduous forests, and grasslands. In the northern states *Grimmia* is found at elevations of 500-600 m a.s.l., while in central Mexico some species may reach 4600 m. Samples of *Grimmia* from Oaxaca and Chiapas were obtained at 2950-3270 m a.s.l., but the altitudinal range for the genus there may be as low as 1944 m a.s.l. Exploration in *Pinus* forests yielded *G. longirostris, G. pilifera*, and *G. trichophylla* in the state of Oaxaca. The last one is the only species of the genus known from Chiapas. The specimens listed in Table 1 and those cited by Delgadillo and Cárdenas (1989) from the same area represent the first records of the genus for Chiapas. All of them were collected in a disturbed *Pinus* forest on top of the Cerro Mozotal.

While the pine forest of the summit of Cerro Mozotal seems the habitat where *Grimmia* would be expected to occur, the accompanying moss flora is usually part of other plant communities. *Braunia imberbis* (Sm.) N.J. Dalton & D.G. Long, *Polytrichastrum tenellum* (Müll. Hal.) G.L. Sm., and *Racomitrium subsecundum* (Hook. & Grev. ex Harv.) Mitt. & Wilson are alpine/subalpine species; *Caribaeohypnum polypterum* (Mitt.) Ando & Higuchi, *Dendropogonella rufescens* (Schimp.) E. Britton, and *Prionodon* spp. are examples from cloud forests (Table 2).

Discussion

The number of species of *Grimmia* detected in southern Mexico is surprisingly low, particularly in the states of Oax-

Table 1: Specimens of *Grimmia* Hedw. collected in Oaxaca and Chiapas. AC=Ángeles Cárdenas; CD=Claudio Delgadillo; EH=Enrique Hernández; PP=Paola Peña; AJS=Aaron J. Sharp. All specimens were deposited in the Bryophyte Collection at MEXU.

Species	State	Locality/Specimens	Coordinates
Grimmia longirostris Hook.	Oaxaca	Cerro Corral de Piedra: *AC 4294*; *CD 4852*	17°10'N - 96°39'W
		Camino a Sta. María, ca. Mitla: *CD 7553*	16°55'N - 96°17'W
Grimmia pilifera P. Beauv.	Oaxaca	Ixtlán: *EH 155*	17°18'N - 96°29'W
		Luvina: *EH 687*	17°30'N - 96°32'W
		East of La Cumbre: *AJS 2608*	17°11'N - 96°36'W
Grimmia trichophylla Grev.	Oaxaca	Cerro Corral de Piedra: *CD 4854*	17°10'N - 96°39'W
		Cerro Pelón: *CD 7546*	17°34'N - 96°30'W
		El Cuartel: *CD 7554*	17°10'N - 96°37'W
		Tres Ocotes: *CD 7723*	16°11'N - 96°26'W
		Ozolotepec: *CD 7730, 7733*	16°07'N - 96°13'W
Grimmia trichophylla Grev.	Chiapas	Cerro Mozotal: *CD 7841, 7855; PP 404, 419*	15°26'N - 92°20'W

aca and Chiapas that exhibit topographic elevations and types of vegetation that seem regular habitats for several species elsewhere. According to their known altitudinal range in Mexico and their potential distribution (Delgadillo et al., 2012), at least eight species would be expected in the area, but field work revealed only three of them (Table 1). *Grimmia elongata* Kaulf., *G. mexicana* Greven, and *G. ovalis* (Hedw.) Lindb. have been reported from northwestern Guatemala; *G. longirostris* and *G. trichophylla* have a broader range in Central America. There are no records of *G. fuscolutea, G. pulla* Cardot, and *G. torquata* Drumm. All three species form spores or gemmae that would enable them to spread into available habitats, but their consistent absence in southern Mexico suggests that other environmental or historical variables control their establishment.

The peculiar habitat of *G. trichophylla* in Chiapas is of interest; high altitude pine forests are the usual vegetation for this taxon. However, on the Cerro Mozotal it dwells with other alpine or subalpine mosses and species from deciduous or tropical derivation. Graham (1973) has shown that members of the arborescent temperate element migrated into Mexico since the Eocene and moved progressively southwards; *Abies* Mill., *Picea* A. Dietr., *Alnus* Mill., *Fagus* L., *Juglans* L., *Liquidambar* L., and others reached southern Mexico by the mid-Miocene. This fact may explain the presence of temperate mosses in Chiapas, i.e., species that moved along with the vascular plant flora; the tropical taxa perhaps derive from montane forests from lower elevations. The presence of the alpine and subalpine mosses (Table 2), including some species of *Grimmia*, may be related to high elevation habitats in Chiapas that may have become available by the late Tertiary (cf. López Ramos, 1983) and were filled by new arrivals.

Field and herbarium work resulted in more than 900 Mexican specimens for study (Delgadillo, 2015). These specimens and bibliographic information show that most species of *Grimmia* are unknown from southern Mexico and Central America. The lower altitude of the Central American mountains, relative to those in the Neovolcanic Belt and the northern Andes, would not facilitate the spread of *Grimmia* from the north or from the south. However, since the distribution of most species of that genus does not extend southwards beyond the Neovolcanic Belt one must conclude that the original hypothesis of a northern origin in Mexico is the most suitable explanation. The broad continental ranges of *G. longirostris* and *G. trichophylla* do not give definite support to a northern or southern origin, but the northern option is preferred because the Isthmus of Panama is considered a barrier, not a corridor, for high montane elements (Simpson and Neff, 1985). According to these authors, even a 1200 m lowering of the vegetational belts would not provide continuous cool high forest areas

Table 2: Mosses from the summit of Cerro Mozotal associated with *Grimmia trichophylla* Grev. and their main habitat in Mexico. Species marked with an asterisk (*) are new records for Chiapas. CD=Claudio Delgadillo; DEB=Dennis E. Breedlove; PP=Paola Peña. All specimens were deposited in the Bryophyte Collection at MEXU.

Species	Specimens	Habitat
Anoectangium aestivum (Hedw.) Mitt.	*CD 7862*	Coniferous forests
Anomobryum julaceum (Schrad. ex G. Gaertn., B. Mey. & Schreb.) Schimp.	*PP 424a*	Coniferous forests
Bartramia longifolia Hook.	*PP 423*	Cloud forest/subalpine
Braunia imberbis (Sm.) N.J. Dalton & D.G. Long	*CD 7840*	Alpine/subalpine
Breutelia subarcuata (Müll. Hal.) Schimp.	*CD 7833*	Coniferous forests
Bryum billarderi Schwägr.	*DEB 68819; PP 410*	Pine forests and oak forests
Campylopus pilifer Brid.	*CD 7852*	Pine-oak forests
Caribaeohypnum polypterum (Mitt.) Ando & Higuchi	*CD 7836*	Cloud forest
Dendropogonella rufescens (Schimp.) E. Britton	*CD 7847*	Cloud forest
**Dicranum scoparium* Hedw.	*CD 7834, 7838*	Coniferous forests
Didymodon rigidulus Hedw. var. *icmadophilus* (Schimp. ex Müll. Hal.) R.H. Zander	*PP 424b, CD 7860*	Oak forests
Entodon hampeanus Müll. Hal.	*PP 409*	Cloud forest
Herzogiella cylindricarpa (Cardot) Z. Iwats.	*CD 7851*	Coniferous forests
**Leptodontium capituligerum* Müll. Hal.	*PP 407*	Coniferous forests
Leptodontium flexifolium (Dicks.) Hampe	*CD 7844, 7846*	Alpine
Loeskeobryum brevirostre (Brid.) M. Fleisch.	*CD 7857*	Cloud forest
Macromitrium longifolium (Hook.) Brid.	*PP 420, 425*	Cloud forest
Mittenothamnium reptans (Hedw.) Cardot	*PP 421a*	Cloud/Coniferous forests
Pilotrichella flexilis (Hedw.) **Å**ngstr.	*PP 422, CD 7849*	Cloud forest
Plagiothecium drepanophyllum Renauld & Cardot	*PP 411*	Coniferous forests
Polytrichastrum tenellum (Müll. Hal.) G.L. Sm.	*CD 7839*	Alpine/subalpine
Prionodon fuscolutescens Hampe	*CD 7848*	Cloud forests
Prionodon luteovirens (Taylor) Mitt.	*CD 7858*	Cloud forests
**Racomitrium subsecundum* (Hook. & Grev. ex Harv.) Mitt. & Wilson	*CD 7837, 7854*	Alpine/subalpine
Rozea andrieuxii (Müll. Hal.) Besch.	*CD 7845*	Coniferous forests
Thuidium assimile (Mitt.) A. Jaeger	*PP 421b*	Coniferous forests

between North and South America. Present distribution of these two species is perhaps associated with lower mountain habitats unlike other species in the Mexican highlands. Undoubtedly, additional geological, geographic, and floristic information is required to understand the history of the area; a sample of our incomplete knowledge is illustrated by the new records for the Chiapas moss flora as given in Table 2.

Author contributions

CDM and PPR participated in field work and specimen identification. CDM prepared the manuscript assisted by PPR.

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