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A synopsis of *Woodwardia* (*Blechnaceae*) in Veracruz State, Mexico, and typification of *W. spinulosa*

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Abstract: A synopsis of species belonging to the genus *Woodwardia* Sm. (*Blechnaceae*) from Veracruz State, Mexico, is presented. Three species (including one hybrid species) are recognized as inhabiting Veracruz: the widespread *W. spinulosa* M. Martens & Galeotti, which grows in montane rain forests; the Mexican endemic *W. martinezii* Maxon ex Weath., growing in mesic woods; and *W. xsemicordata* Mickel & Beitel (*W. martinezii* × *W. spinulosa*), found in both deciduous and evergreen forests. An identification key to the three species is provided and the name *W. spinulosa* is lectotypified.

Key words: *Blechnaceae*, ferns, identification key, Mesoamerica, Mexico, pteridophytes, taxonomy, typification, Veracruz, *Woodwardia*, *Woodwardioideae*

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Introduction

Mexico has one of the most diverse fern floras of the world, comprising some 1063 taxa belonging to 146 genera, of which 187 species are endemic (Palacios-Rios 2016a, 2016b). The state of Veracruz, with 572 species (Palacios-Rios 1992), is the third-richest in terms of total fern diversity, after Oaxaca (690 species; Mickel & Beitel 1988) and Chiapas (609 species; Smith 1981, 1986).

The woodwardioid ferns (*Woodwardioideae*, *Blechnaceae*) comprise 15 species treated in one genus, *Woodwardia* Sm., or distributed among three genera: *Anchistea* C. Presl, *Lorinseria* C. Presl, and *Woodwardia*. We adopt

the latter taxonomy, following the classification proposed by Gasper & al. (2016) and PPG I (2016). The former two genera are monotypic and are confined to E North America, whereas the more diverse genus *Woodwardia* is found throughout the warm-temperate and subtropical regions of the N hemisphere in a classic Arcto-Tertiary distribution pattern, with E Asia as the centre of diversity of the genus (Kramer & al. 1990). *Woodwardia* can be distinguished from the other genera in the subfamily *Woodwardioideae* by the monomorphic leaves and the usually shortly creeping to suberect rhizomes (Gasper & al. 2016). So far, 13 or 14 taxa have been recognized, of which three or four are reported from Mexico.

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The most widespread species, which also occurs in some Central American countries to the south of Mexico, is *Woodwardia spinulosa* M. Martens & Galeotti, a species variable in lamina and pinna size and shape, as well as in width and lobing of pinnules and density of indumentum on the abaxial surface of the blades (Mickel & Smith 2004).

During the preparation of both a taxonomic account of the genus *Woodwardia* in Veracruz State and the treatment of the family *Blechnaceae* for the Flora de Veracruz project, it became apparent that the widespread species *W. spinulosa* had never been formally typified. According to Turland (2013), untypified names are of uncertain application and are thus potentially unstable. In order to avoid any ambiguity regarding the application of the name *W. spinulosa*, we here present a nomenclatural study of the untypified name and designate a lectotype. Also we present here a first synopsis of the genus *Woodwardia* in Veracruz State, based on data compiled from field work carried out in Veracruz by the first author, herbarium material, literature, and collections from the main herbaria of Mexico, the United States and Europe.

Material and methods

The present study is based on revisions of herbarium collections from Veracruz, Mexico, consulted in the course of preparing a taxonomic treatment of the fern flora of the state, started in 1983. Specimens from the following herbaria were surveyed: B, BM, BR, BRIT, CAS, CHAPA, CHIP, CORU, CR, DS, ENCB, F, FCME, GH, IEB, K, M, MA, MEXU, MICH, MO, NY, P, RB, SI, UAMIZ, UC, US, WIS, XAL and XALU (herbarium codes according to Thiers 2017+).

Results and Discussion

Key to the species of *Woodwardia* in Veracruz State

1. Leaves with 4 or 5 pairs of free pinnae below pinnatifid apex; pinnae with rounded, shortly decurrent bases; spores 64 per sporangium *W. spinulosa*
- Leaves with only 1 pair of free pinnae below pinnatifid apex; pinnae shortly decurrent to cuneate; spores 32 per sporangium, or spores abortive **2**
2. Sori on distal $\frac{1}{3}$ – $\frac{1}{2}$ of pinna, remote; rhizome scales 10–20 mm long; spores abortive . . *W. xsemicordata*
- Sori along entire length of pinna, approximate to confluent; rhizome scales 6–10 mm long; spores 32 per sporangium *W. martinezii*

Woodwardia martinezii Maxon ex Weath. in Amer. Fern J. 39: 88. 1949 \equiv *Chieniopteris martinezii* (Weath.) Pic. Serm. in Webbia 31: 254. 1977. – Holotype: Mexico,

Hidalgo, near Zacualtipán, 1800 m, 15 Apr 1940, *M. Martinez* 27 (US! [accession no. 1791178, barcode US00067459]; isotypes: ARIZ, B!, BR!, CAS!, COL, DAO, DUKE [2 sheets], E, ENCB!, FI, LL, MEXU!, RB, RSA, TEX, U, UC!, WIS [3 sheets], WTU).

Distribution and ecology — Endemic to Mexico (states of Hidalgo, Puebla and Veracruz); terrestrial, in mesic woods, often in ravines, from 1500–1900 m.

Remarks — The species may be apomictic, given that it differs from its allies in having 32 spores per sporangium instead of 64.

Additional specimens examined — MEXICO: VERACRUZ STATE: Mun. Huayacocotla: El Salto en Helechales, *Ballesteros & Ballesteros* 410 (XAL); Agua de la Calabaza, *Ballesteros & Morales* 22 (ENCB, IEB, XAL); Arroyo Helechales, *Ramírez* 562 (XAL). Mun. Misantla: Pas de Enrique cloud forest, 15 km S of Misantla, *Bohs & al.* 1808 (F); 10 km W de Misantla, carretera Xalapa-Misantla, *Dorantes & Acosta* 2373 (XALU). Mun. Nautla: Teziutlán-Nautla road, 12 km from Teziutlán, *Sánchez* 339 (US). Mun. Texcatepec: entre El Baldo y Agua Linda, *Turra* 2766 (ENCB).

Woodwardia xsemicordata Mickel & Beitel in Mem. New York Bot. Gard. 46: 403. 1988. – Holotype: Mexico, Veracruz, Orizaba, 1855, *Müller 1485bis* (NY! [barcode NY00179355]).

Distribution and ecology — Endemic to Mexico (states of Chiapas, Estado de México, Hidalgo, Oaxaca, Puebla and Veracruz); in forests of *Liquidambar*, *Pinus* and *Pinus-Quercus*, from 1000–2360 m.

Remarks — *Woodwardia xsemicordata* is an abortive-spored hybrid of *W. martinezii* and *W. spinulosa*.

Additional specimens examined — MEXICO: VERACRUZ STATE: Mun. Altotonga: 1.5 km W of Orilla del Monte, 14 km (by air) NW of town of Perote, *Nee* 23471 (F, NY, XAL); 15 km N of town of Perote on road to Altotonga, *Nee* 23542 (F, NY, XAL). Mun. Banderilla: Rancho “La Mesa”, *Palacios-Rios* 3296 (XAL); carretera Xalapa-Perote, cerca de un reservorio de agua, *Palacios-Rios* 3403 (XAL); carretera Xalapa-Perote, cerca de un reservorio de agua, *Pérez-García* 317 (XAL); al NE de Banderilla, rancho “La Martinica”, *Calzada* 7882 (IEB, XAL). Mun. Chiconquiaco: Cañada del Huérfano, *Gómez-Pompa & Riba* 385 (MEXU). Mun. Huayacocotla, El Salto Helechales, camino a Las 3 Cascadas, *Ballesteros, & al.* 272 (XAL); cerca de Agua de La Calabaza, camino a Las 3 Cascadas, 17 km NE de Huayacocotla, *Juárez & Vázquez* 32 (F, XAL); Rancho Quemado, 3 km al SE de Huayacocotla, *Vázquez* 1227 (XAL). Mun. Las Vigas, “El Volcan-

cillo”, *Dorantes & al.* 5104 (XAL). Mun. Xalapa, Jalapa, A. S. *Hitchcock s.n.* (US); Rancho Guadalupe, 3 km W de Xalapa, carretera vieja Xalapa-Coatepec, *Calzada & al.* 1939 (MEXU, MO, XAL); camp near Jalapa, *Halsted* 9 (NY); about 2 miles S of Jalapa, on road to Coatepec, *Correll & Correll* 28759 (LL, MEXU, TEX); entre Xalapa y Coatepec, *Sánchez-Mejorada* 943 (MEXU); Jalapa, *Smith* 2154 (F, UC); Jalapa, *Smith s.n. b* (MO accession no. 1877896, MO accession no. 1877897, UC). Mun. Yecuatla, 12 km S of Misantla, *Bohs & al.* 1696 (GH, XAL).

Woodwardia spinulosa M. Martens & Galeotti in Nouv. Mém. Acad. Roy. Sci. Bruxelles 15 [Mém. Foug. Mexique]: 64. 1842. – **Lectotype (designated here):** Mexico, Veracruz, Orizaba, 3400 m, *H. Galeotti* 6255 (RB! [register no. 215617, barcode RB00603390]). – Fig. 1.

Typification — In the protologue of *Woodwardia spinulosa* (Martens & Galeotti 1842: 64), the authors cited two localities on Pico de Orizaba, Veracruz, Mexico: “la caverne del Temascal, sur le versant oriental du pic d’Orizaba, et près des ruisseaux de la Vaqueria del Jacal, situés à 3000 pieds plus bas que la caverne”; they also cited the gathering *H. Galeotti* 6255. The second locality, the Vaqueria del Jacal, was described under *Pteris orizabae* M. Martens & Galeotti (l.c.: 52–53), as “vacherie située sur le versant méridional du pic d’Orizaba”.

Mickel & Beitel (1988) and Mickel & Smith (2004) suggested that the collecting number given for *Woodwardia spinulosa* by Martens & Galeotti was likely an error and should have been *H. Galeotti* 6573 because the only specimens known to them of *W. spinulosa* collected by Galeotti were nine sheets in BR, five of them from Cerro San Martin, three from Veracruz, and one from Oaxaca, all specimens with the number 6573. However, none of these sheets is annotated with either of the localities cited in the protologue, and one of the sheets, from Cerro San Martin (barcode BR0000006985356), bears the date “Mai 1845”, i.e. three years later than the protologue. Therefore, these sheets cannot be regarded as original material for the name. In 1995, one of us (M.P.-R.) annotated the sheet BR0000006985356 as the lectotype, but this cannot be followed because the specimen is not eligible as the lectotype and the type designation was not effectively published (McNeill & al. 2012: Art. 7.9).

Mickel & Smith (2004) stated that “The BR specimen of *Galeotti* 6255 is *Cochlidium serrulatum*, Veracruz, 8000’”, but after an exhaustive search we were unable to find such a specimen, or indeed any specimen in BR labelled as *H. Galeotti* 6255. However, we wonder if Mickel & Smith might have erroneously cited the number 6255 in connection with *C. serrulatum* (Sw.) L. E. Bishop (*Polypodiaceae*). In the same work as the protologue of *W. spinulosa*, Martens & Galeotti (1842: 29) recorded *C. serrulatum* (as *Xiphopteris serrulata* (Sw.) Kaulf.) from pic d’Orizaba, citing the gathering *H. Galeotti* 6455.

During the course of a review of specimens in different herbaria, we have located only one specimen of *Woodwardia spinulosa* with the collector and number *H. Galeotti* 6255, conserved in the Fée herbarium in RB with the collection locality “Mexique, Orizaba, à 3.400 metres”. McNeill (2014) stated “In situations in which no type is designated but reference is made to only a single specimen or gathering, there will be a holotype only if it can be established that no additional elements were used”. The locality, collector and number of the specimen in RB all correspond with those cited in the protologue of *W. spinulosa*; we are therefore confident that this specimen is part of the original material of the name *W. spinulosa* and we designate it here as the lectotype. We do not regard this specimen as the holotype because we cannot be sure that this was the only element used by Martens & Galeotti in preparing the protologue of *W. spinulosa*. They mentioned two localities, so there could be other gatherings, or duplicates of *H. Galeotti* 6255 in other herbaria, and possibly some specimens have been lost or destroyed.

Distribution and ecology — El Salvador, Guatemala, Honduras, Mexico (Chiapas, Chihuahua, Distrito Federal, Durango, Estado de México, Guanajuato, Guerrero, Hidalgo, Jalisco, Michoacán, Morelos, Nayarit, Nuevo León, Oaxaca, Puebla, San Luis Potosí, Sinaloa and Veracruz) and Nicaragua; terrestrial, usually in ravines or on steep banks near streams in montane rain forests, forests of *Liquidambar*, *Pinus*, *Pinus-Quercus* and *Quercus*, from (1200–)1850–2350(–3400) m.

Remarks — *Woodwardia spinulosa* is the most widespread species of *Woodwardia* in Veracruz; It is distinguished from *W. fimbriata* Sm., known from the Pacific coast of North America (from British Columbia south to México), by having abaxial costae, veins and lamina with fibrillose scales, and distal pinnae with shortly decurrent bases, but lacking numerous large, pale yellow resin glands on the abaxial surface. *Woodwardia spinulosa* is variable in size and shape of the lamina and pinnae, as well as in width and lobing of the pinnules and density of indumentum abaxially on the lamina (Mickel & Smith 2004).

Additional specimens examined — MEXICO: OAXACA STATE: Oaxaca, *H. Galeotti* 6573 (BR). — VERACRUZ STATE: prov^{ce} Veracruz, *H. Galeotti* 6573 (BR [3 sheets]); Veracruz, *Mohr* 36 (B, US); Veracruz, *Müller s.n.* (NY); probably Veracruz, *Schaffner* 268 (K); probably Veracruz, *Uhde* 36 (B). Mun. Altotonga, 5 km SW of Altotonga along road to Champilico, *Taylor & Nee* 330 (F, NY, XAL). Mun. Atzalan, La Florida, *F. Ventura* 189 (ENCB, NY). Mun. Banderilla, adelante de Jalapa, km 315 (Jalapa-Perote), *Herrera & al.* JB-1264 (MEXU); a 2 km de Banderilla, carretera Xalapa-Perote, cerca de un reservorio de agua, *Palacios-Rios* 3403 (XAL). Mun. Calcahualco, 1 km al E de Calcahualco, Barranca de Jamapa, *Martínez & Acosta P.* (XAL); 500 m al SW de



Fig. 1. Lectotype of *Woodwardia spinulosa* H. Martens & Galeotti: H. Galeotti 6255 (RB [register no. 215617, barcode RB00603390]). – Reproduced with permission of the Herbarium of the Jardim Botânico do Rio de Janeiro (RB).

Maquistla, camino a Jacal, *J. L. Martínez & F. Vázquez* 539 (IEB, XAL). Mun. Chocamán, puente sobre el Río Jamapa, adelante de Chocamán, *Herrera & al. JB-1211* (MEXU). Mun. Coscomatepec, Coscomatepec, *Kempton & Collins s.n.* (US). Mun. Huatusco, Huatusco, *Liebmann s.n.* (K). Mun. Huayacocotla, El Salto, en Helechales, por la Vereda Tzimentey, *Ballesteros & Ballesteros* 347 (XAL); Vereda Tzimentey, cerca del límite al SE de la reserva propuesta, *Ballesteros & Ballesteros* 419 (XAL); 1 km E of Viborillas, 4 km S of Huayacocotla, 21 Jul 1982, *Diggs & Nee* 2907 (F, XAL); El Paraje, *Hernández & Cedillo* 814 (MEXU, XAL); Palo Bendito, *Hernández* 1531 (F, MEXU); 2 km de Huayacocotla a Viborillas, *Nevling & Gómez-Pompa* 1938 (MEXU); Helechales, barranca paralela a las cascadas, *Ramírez* 523 (XAL); cañada de Las 3 Cascadas, *Ramírez* 620 (XAL). Mun. Ixhuacán de Los Reyes, 2 km (by road) W of Ixhuacán de Los Reyes and 2.2 km (by road) E of Ayahualulco, *Nee & Taylor* 25959 (F [2 sheets], NY, XAL). Mun. Jalacingo, 10 km adelante de Jalacingo, rumbo a Perote, *Nevling & Gómez-Pompa* 1063 (MEXU). Mun. La Perla, La Perla, *Copeland* 53a (B, BM, MICH, UC, US). Mun. Las Minas, al SE de Rinconada por el Cerro La Tolva, *Durán & Burgos* 575 (IEB, XAL). Mun. Maltrata, Maltrata, *Matuda* 1364 (MEXU). Mun. Misantla, “montagnes près Misantla”, *Hahn s.n.* (B, K, NY, US [2 sheets]). Mun. Orizaba, Lomogrande, Mt Orizaba, 8900 ft., growing in deep barrancas, in moist shade, under trees and shrubs, fronds to 6 ft long, *Balls* B4375 (K, UC, US). Mun. Perote, above Los Molinos, Perote, *Balls* 4558 (K); Monte San Cristobal, Orizaba, 6000', damp woods, *Botteri s.n.* (US); Monte Azul, Región d'Orizaba, monte Azoul, *Bourgeau* 3151 (BR, US); Orizaba, *Lemmon* 330 (UC). Mun. San Rafael, San Rafael, *Guillemin* 3151 (NY). Mun. San Andrés Tuxtla, Volcán Tuxtla, *H. Galeotti* 6573 (BR); pied du cratère du C°. S. [Cerro San] Martin, *H. Galeotti* 6573 (BR, XAL). Mun. Xalapa Salto del Gato, W de Xalapa, *Acosta & Dorantes* 203 (ENCB); near Jalapa, *Barnes & al.* 76 (F); Rancho Guadalupe, 3 km W de Xalapa, carretera vieja Xalapa-Coatepec, *Calzada & al.* 1939 (MEXU, MO); Salto del Gato, along Río Sedeño, about 3 km NE of Xalapa, *Conant* 805 & *al.* (GH, MEXU); Salto del Gato, *Dorantes* 455 (F, MEXU); in Monte Gacho bei Jalapa, *Endlich* 1706 (B); Parque Clavijero, antes Rancho Guadalupe, *Ortega* 1350 (F). Mun. Xico, cascadas de Texolo, *Frías* 14 (XALU); Xico, 2500 m, *Johnson s.n.* (US); gorge below Teocelo Falls, *Johnson* 529 (NY); fondo de la Barranca “El Caracol”, *Narave & Vázquez* 418 (XAL). Mun. Vigas de Ramírez, Pedregal Las Vigas, carretera Xalapa-Perote, *Dorantes & M. Acosta* 2397 (XALU); Las Vigas, El Volcancillo, *Dorantes & al.* 5104 (ENCB, F, MEXU, NY, XAL); Las Vigas, cráter “El Volcancillo”, *Ortega & al.* 131 (ENCB, F, IEB, MEXU, NY, XAL, XALU); Las Vigas (Rafael Ramírez), Dos Veredas, *Ventura* 7545 (ENCB). Mun. Zongolica, km 18 carretera Orizaba-Zongolica, *Palacios-Rios & Hernández M.* 532 (ENCB, UAMIZ).

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