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## A new species of *Merostachys* (Poaceae: Bambusoideae: Bambuseae: Arthrostylidiinae) with the northernmost distribution of the genus

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### Abstract

With 52 described species, *Merostachys* is the most diverse genus in the Arthrostylidiinae; 50 of the species are present in South America and only two, *M. latifolia* and *M. pauciflora*, are distributed in Central America and Mexico. Previous collections of vegetative *Merostachys* specimens from El Triunfo, Chiapas, Mexico, were identified as *M. pauciflora*. However, new flowering collections from the state of Tabasco, Mexico, allowed us to differentiate the Mexican populations from *M. latifolia* and *M. pauciflora*. A detailed study of samples from the Tabasco population, and a review of the previous collections from Chiapas, confirmed the existence of a new *Merostachys* species, which we here describe and illustrate as *M. mexicana*. This new species is endemic to Mexico and represents the northernmost extension of the genus.

**Keywords:** Chiapas, endemic, montane cloud forest, Mexico, Tabasco.

### Introduction

*Merostachys* Sprengel (1825: 132) is one of the 15 genera that belong to the monophyletic Neotropical woody bamboo subtribe Arthrostylidiinae (Judziewicz *et al.* 1999, Tyrrell *et al.* 2012, Viana *et al.* 2013, Kellogg 2015, Wysocki *et al.* 2015, Soreng *et al.* 2017, Saarela *et al.* 2018). The most recent molecular phylogeny of the Arthrostylidiinae, by Tyrrell *et al.* (2012), showed that *Merostachys* is a monophyletic genus sister to *Actinocladum* McClure ex Soderstrom (1981: 1201). *Merostachys* is defined by the combination of short-necked, pachymorph rhizomes; usually hollow culms; culm leaves with the blades pseudopetiolate and usually reflexed; one bud per mid-culm node producing a fan-shaped (apsidate) array of subequal branches; racemose, often densely one-sided synflorescences; spikelets with usually two unequal glumes; and usually one floret (uncommonly two to several), with a rachilla extension; and a nucoid caryopsis (McClure 1973, Judziewicz *et al.* 1999).

*Merostachys*, with 52 described species, is the most species-rich genus in the subtribe Arthrostylidiinae (Santos-Gonçalves *et al.* 2012, Clark *et al.* 2015, Parma *et al.* 2016, Vinicius-Silva *et al.* 2016), followed by *Aulonemia* Goudot (1846: 75) with 48 species (Clark *et al.* 2015). In the last 20 years, 19 *Merostachys* species have been described, 18 of them from Brazil (Sendulsky 1997, 2001, Santos-Gonçalves *et al.* 2012, Parma *et al.* 2016, Vinicius-Silva *et al.* 2016) and only one from Bolivia (Lizarazu *et al.* 2011). *Merostachys* has an interesting geographical distribution, with 50 of the species located in South America and only two of them in Central America and Mexico, with southern Mexico representing the northernmost distribution limit of the genus (Judziewicz *et al.* 1999, Parma *et al.* 2016, Vinicius-Silva *et al.* 2016). Of those 50 South American species, 44 are distributed in Brazil mainly in the Atlantic forest biome (Vinicius-Silva *et al.* 2016) and thus the Atlantic forest is clearly the center of diversity of *Merostachys*. The species of *Merostachys* grow from sea level to 2300 m in tropical, subtropical and montane cloud forests (Judziewicz *et al.* 1999, Judziewicz & Clark 2007).

The only two described species from Central America are *Merostachys pauciflora* Swallen in Lundell (1943: 469) and *M. latifolia* R.W. Pohl in Davidse & Pohl (1992: 88). The latter species has a geographical distribution that comprises Belize, Costa Rica, Guatemala, Honduras, Nicaragua and Panama, growing in montane cloud forest (Davidse & Pohl 1992, Pohl & Davidse 1994). On the other hand, *M. pauciflora* has a geographical distribution in Belize and reportedly also in Nicaragua, in tropical rain forest (Pohl & Davidse 1994). Pohl & Davidse (1994) in the Flora Mesoamericana treatment of Poaceae indicated that this species may occur in Chiapas, Mexico. In 1982, Gilberto Cortés collected a sterile *Merostachys* specimen from El Triunfo, Chiapas, in the montane cloud forest, later annotated as *M. pauciflora*. New specimens from the same population were collected in 2011 for the Mexican bamboos barcode project and again identified as *M. pauciflora*. Due to uncertainty about the correct determination of this species, however, Ruiz-Sanchez *et al.* (2015) treated this entity as *Merostachys* sp.

During fieldwork in the state of Tabasco in 2015, a flowering *Merostachys*, morphologically similar to *M. latifolia* and *M. pauciflora* and the collections from Chiapas, was collected in the montane cloud forest. Detailed study of samples from this population, and a review of herbarium specimens from Chiapas and Central America, confirmed the existence of a new *Merostachys* species. Hence, we here describe and illustrate this new taxon that is endemic to Mexico, and compare it with the other two Central American *Merostachys* species.

***Merostachys mexicana*** Ruiz-Sanchez & L. G. Clark *sp. nov.* (Figs. 1–3)

TYPE:—MEXICO. Tabasco: Huimanguillo, parte alta del cerro Las Flores, al W de Villa de Guadalupe, 17°21'50.4" N, 93°37'59" W, 1010 m, 18 junio 2015 (fl), S. Zamudio, D. Juárez y J. Hernández Rendón 16946 (holotype IBUG!, isotypes ISC!, MEXU!, MO!, US!, XAL!).

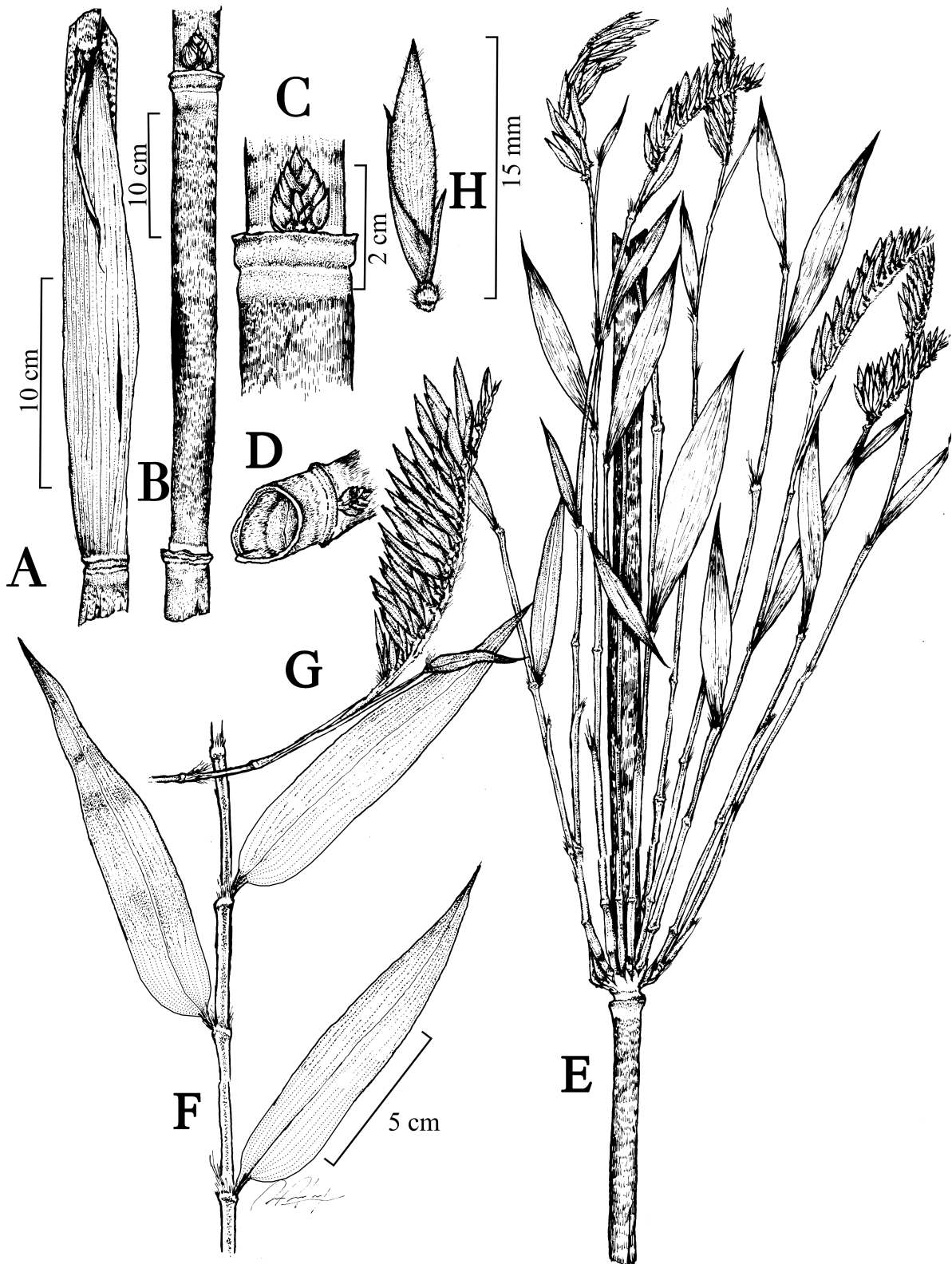
*Merostachys mexicana* is similar to *M. latifolia* and *M. pauciflora*, but differs in having two glumes per spikelet, longer upper glumes, and longer lemmas.

Rhizomes pachymorph with necks 5–10 cm long. Culms 6–10 m tall, 1–2 cm in basal diameter, erect then clambering on vegetation; internodes 30.5–43 cm long, hollow, cylindrical, greenish, mottled with green spots, asperous and retrorsely bearded, walls 1.5–2 mm thick, the lacuna occupying >70% of the total diameter; nodes with an infranodal band of sericeous hairs, the band 4–5 mm wide. Culm leaves 25–35.5 cm long, with sericeous hairs at the juncture of the sheath and the node; sheaths 18–24.5 cm long, adaxially glabrous and shiny, abaxially glabrous but pruinose at the base, apex fimbriate, margins apically fimbriate becoming ciliate along the sheath; fimbriae 10–23 mm long, free, straight at the base and sinuous at the apex, whitish; inner ligule 0.8–1 mm long, membranous, ciliate; blades 7–11 cm, scabrous on the adaxial surface, glabrous on the abaxial surface, margins serrulate, bright green on live plants, apex acute. Branch complement with (7–) 10–25 branches, the branches 20–56 cm long, ca. 2 mm in diam., lower nodes not rebranching; nodes prominent, thickened, ring-like, whitish, with an infranodal band of sericeous hairs. Foliage leaves 6–7(–10) per branch; sheaths glabrous, overlapping margin ciliate; auricles absent; outer ligule 0.2 mm long, apex fimbriate; fimbriae 5–10 mm long, not fused, straight to sinuous, whitish; inner ligule 0.2 mm long, membranous, glabrous, minutely ciliate; pseudopetioles 3–4 mm long, brownish, glabrous, straight to twisted; blades 7.5–11.5 (–15.5) × 1.8–2.1 (–2.7) cm, lanceolate to ovate-lanceolate, with a marginal stripe on the abaxial side, both sides glabrous, the base oblique, the apex acuminate, margins serrulate. Inflorescences 5–8 cm long, racemose, pectinate, with 18–26 spikelets per inflorescence; rachis sericeous; pedicels ca. 1 mm long, sericeous. Spikelets 13–15 mm long, solitary, slightly falcate; glumes 2, unequal, puberulous abaxially, margins ciliate; lower glume 3–4 mm long, 1-nerved; upper glume 8–9 mm long, mucronate, 14–16-nerved; lemma 12–14 mm long, 15–17-nerved, abaxially pubescent, margins ciliate; palea 11–13 mm long, 9–10-nerved, abaxially glabrous, awnless, margins entire, the two central nerves keeled and forming a sulcus; sulcus narrow, ciliate towards the apex, tightly clasping the rachilla extension; rachilla extension 9–14 mm long, tipped with a minute rudimentary floret; lodicules 3, 1–1.5 mm long, membranous and apically ciliate; androecium with three stamens, anthers 6 mm long; gynoecium with an elongate ovary, style bifid, stigmas 2, plumose. Caryopsis nuroid, stramineous, 7–8 mm long, mucronate.

**Habitat and distribution:**—The new species is only known from two populations; the first is the type population located in the state of Tabasco and the second in the El Triunfo national reserve in the state of Chiapas. *Merostachys mexicana* inhabits montane cloud forest *sensu* Rzedowski (1978) at elevations of 1000 to 2080 m a.s.l.

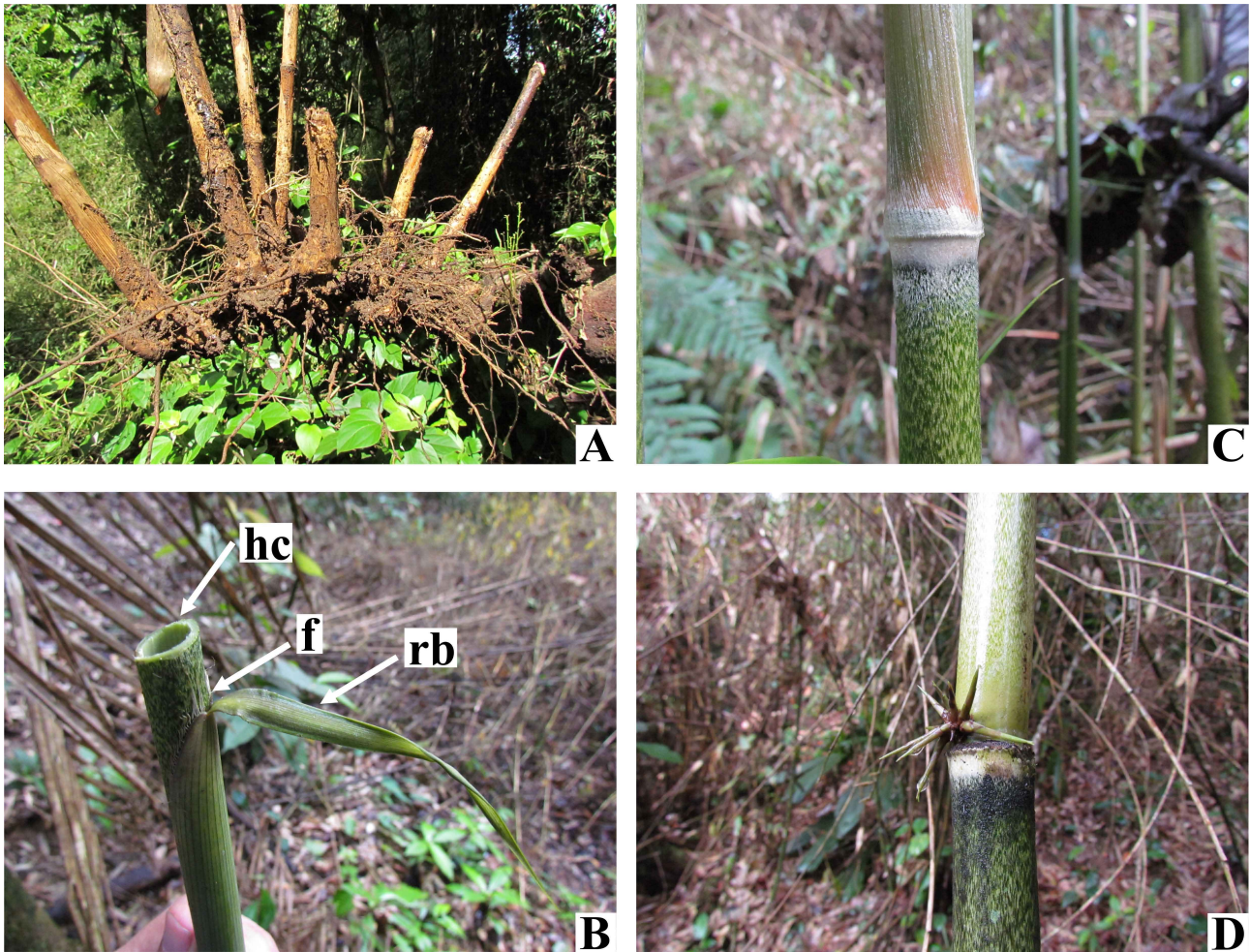
**Comparison with other species:**—On the basis of vegetative morphology and reproductive characters, *Merostachys mexicana* is most similar to *M. pauciflora* and *M. latifolia*. These species are similar in habit, with erect culms that then clamber on other vegetation. However, *M. pauciflora* has inflorescences consisting of 1 to 8 spikelets with one spikelet per inflorescence node while *M. mexicana* and *M. latifolia* have inflorescences consisting of 10 to 30 spikelets, with the spikelets solitary in *M. mexicana* or solitary or paired in *M. latifolia*. *Merostachys mexicana* has two

glumes (lower and upper) whereas *M. latifolia* has only one, lacking the lower glume. The upper glume in *M. mexicana* is larger (8–9 mm) than in both *M. latifolia* (1.5–3.5 mm) and *M. pauciflora* (0.1–2.1 mm). *Merostachys mexicana* has larger fertile lemmas (12–14 mm) than *M. latifolia* (9.5–10 mm).



**FIGURE 1.** *Merostachys mexicana*. A. Culm segment showing a culm leaf with its reflexed blade. B. Internode showing two nodes and bud. C. Detail of the apsidate (fan-shaped) early bud development. D. Culm fragment showing the node and hollow culm with thin walls. E. Culm fragment showing flowering branches. F. Foliage leaf complement. G. Inflorescence showing paired spikelets. H. Spikelet lateral view showing the lower and upper glumes and lemma. Drawing by Daniel Barba based on Ruiz-Sanchez *et al.* 542 (A–D, F) and Zamudio *et al.* 16946 (E, G and H).





**FIGURE 2.** *Merostachys mexicana*. A. Short-necked, pachymorph rhizomes. B. Segment of the culm, showing a culm leaf and its reflexed blade (rb), white fimbriae (f) and hollow culm (hc). C. Internode section showing infra and supranodal bands with sericeous hairs and the pruinose base of the culm leaf sheath. D. Mid-culm section, showing branch complement. Photos by E. Ruiz-Sanchez.

**Etymology:**—The specific epithet relates to its geographical distribution in Mexico.

**Phenology:**—All collections except the type are non-flowering; this is the first reproductive collection for this species and thus we cannot infer the flowering cycle. The flowering pattern best matches the category of gregarious flowering type 2 (“flowering wave”) according to Franklin (2004): most of the individuals flowered, but some sterile individuals were observed. Some seedlings were seen growing under the flowering individuals.

**Additional specimens examined (paratypes):**—MEXICO. Chiapas: Reserva El Triunfo, on muletrack above Santa Rita on the way to the station, Polígono I, 1720 m, 15°41’N, 92°48’W, 19 January 1993, *L. Clark & G. Cortés 1146* (ISC, MEXU); Angel Albino Corzo, campamento El Triunfo bajando por el sendero a Santa Rita, 1750–2066 m, 15°40’56.8”N, 92°47’41.3”W, 21 June 2011, *T. Mejía-Saulés A. Vázquez & R. Percino 2127, 2128, 2129, 2130* (XAL); Jaltenango, reserva natural El Triunfo 6 hrs de camino al w de Finca Prusia, 1900, 15°40’N, 92°48’W, 15 May 1982, *G. Cortés 102* (MO, US). Tabasco: Huimanguillo, Villa Guadalupe, atrás de las torres microondas, 17°21.837’N, 93°37.560’W, 1050 m, 6 November 2015 (fl), *E. Ruiz-Sanchez, A. Ortiz & F. Lorea 542, 542a* (IBUG); Cerro de microondas, 17°21’48”N, 93°37’33”W, 1019 m, 18 June 2017, *F. Lorea & L. Tlaxcalteco 6161* (XAL).

**Key to the species of *Merostachys* in Mesoamerica based on vegetative characters.**

- 1. Branch complement with 25–31 branches; foliage leaf blades 0.9–1.3 cm wide, pseudopetioles 2–3 mm long .....*M. pauciflora*
- 1. Branch complement with 10–25 branches; foliage leaf blades 1.8–5.5 cm wide, pseudopetioles 3–10 mm long .....2
- 2. Branch complement at mid-culm with (7–) 10–25 branches; foliage leaf blades 1.8–2.1 (–2.7) cm wide, pseudopetioles 3–4 mm long .....*M. mexicana*
- 2. Branch complement at mid-culm with 6–10 branches; foliage leaf blades 2.2–5.5 cm wide, pseudopetioles 6–10 mm long .....*M. latifolia*



**Key to the species of *Merostachys* in Mesoamerica based on reproductive characters.**

- 1. Inflorescences of 1 to 8 spikelets; spikelets solitary .....*M. pauciflora*
- 1. Inflorescences of 10 to 30 spikelets: spikelets solitary or paired .....2
- 2. Spikelets solitary or paired, lacking lower glumes, the upper glumes 1.5–3.5 mm long; fertile lemmas 9.5–10 mm long .....*M. latifolia*
- 2. Spikelets solitary, with both lower and upper glumes, the upper glumes 8–9 mm long; fertile lemmas 12–14 mm long.....*M. mexicana*



**FIGURE 3.** *Merostachys mexicana*. A. New erect shoots, showing culm leaves. B. Foliage leaves. C. Abaxial side of the foliage leaf complement showing the marginal stripe (white arrow). D. Foliage leaf complement showing the fimbriae (white arrow). E. Old inflorescences. F. Remnant new inflorescence showing spikelets and stamens. G. Nuroid caryopsis (white arrow). Photos by E. Ruiz-Sanchez.



## Discussion

*Merostachys* and *Actinocladum* are the only two bamboo genera in the America with the nucoid caryopsis type (Judziewicz *et al.* 1999, Tyrrell *et al.* 2012). The rest of the species and genera have the typical basic caryopsis, with the exception of the species in *Alvimia* C.E. Calderón ex Soderstrom & Londoño (1988: 833), *Guadua sarcocarpa* Londoño & P.M. Peterson (1991: 631), *Olmeca recta* Soderstrom (1982: 161) and *O. reflexa* Soderstrom (1982: 161), which produce the fleshy or bacoid caryopsis type (Judziewicz *et al.* 1999, Tyrrell *et al.* 2012, Ruiz-Sanchez & Sosa 2015). *Merostachys mexicana* produces nucoid caryopses and to date is the only Mexican woody bamboo species with this fruit type.

The montane cloud forest in Mexico harbors the richest bamboo diversity in the country with almost 46% of the total diversity (25 species out of 52, including the new *Merostachys*) (Ruiz-Sanchez *et al.* 2015, Ruiz-Sanchez & Castro-Castro 2016, Ruiz-Sanchez *et al.* 2017). *Merostachys mexicana* is one of the species that inhabits this kind of vegetation. Despite its diversity, the montane cloud forest is one of the most threatened types of vegetation in Mexico (Rzedowski 1996, Aldrich *et al.* 2000, Luna-Vega *et al.* 2000), occupying less than 50% of its former total area (Sánchez-Ramos & Dirzo 2014).

*Merostachys mexicana* is now the third *Merostachys* species in Mesoamerica. The genus now comprises 53 described species, with 50 of them distributed in South America (Judziewicz *et al.* 1999, Parma *et al.* 2016, Vinicius-Silva *et al.* 2016), but the center of diversity is clearly in the Atlantic forests of Brazil, where 41 species are documented (Vinicius-Silva *et al.* 2016).

Both *M. mexicana* and *M. latifolia* inhabit the montane cloud forest (Davidse & Pohl 1992, Pohl & Davidse 1994), whereas *M. pauciflora* occupies the tropical rain forest (Pohl & Davidse 1994). Due to the overall morphological similarity among the three species, the Mexican *Merostachys* populations were identified previously as *M. pauciflora* based on vegetative characters. It was not until a new population of the Mexican *Merostachys* was found in the state of Tabasco in bloom that it was possible to find fixed characters, which allowed us to describe *M. mexicana*.

The recognition of *Merostachys mexicana*, a new endemic Mexican woody bamboo species, does not increase the total Mexican bamboo diversity, because it was previously counted as *Merostachys* sp. in Ruiz-Sanchez *et al.* (2015). To date, *M. mexicana* is only known from two populations, the type population located in Tabasco and the second in Chiapas. Both places are difficult to reach and one is in the natural reserve of “El Triunfo” in Chiapas, which ensures some protection for this new species. According to the IUCN (International Union of Conservation of Nature) Red List categories and criteria (IUCN, 2001), *M. mexicana*, if evaluated, would probably be listed as Critically Endangered (CR) given that it appears to meet criterion B (Geographic range) B2 (area of occurrence), a (Severely fragmented or known to exist at no more than five locations), even though one of the two populations is found within a protected area.

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