*Phytotaxa* 328 (2): 101–114
http://www.mapress.com/j/pt/
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**Article**

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

https://doi.org/10.11646/phytotaxa.328.2.1

# *Magnolia montebelloensis*, a new species in section *Magnolia* from Lagunas de Montebello National Park, Chiapas, México, with a key to Magnoliaceae of Chiapas

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## Abstract

A new species of *Magnolia*, from the Lagunas de Montebello National Park, in the central highlands of Chiapas, Mexico, is described and illustrated. *Magnolia montebelloensis* belongs to section *Magnolia*; it differs from *M. poasana* in its smaller habit, densely pubescent terminal twig internodes, stipules and spathaceous bracts, shorter peduncular internodes and more numerous stamens. A key, an ecological and a conservation assessment of the eight Chiapan species of Magnoliaceae are included. *Magnolia montebelloensis* grows in montane rain forest and is contrasted with other Chiapan *Magnolia* species regarding their climate and vegetation preferences. It was assessed as critically endangered (CR) according to IUCN B1ab(ii, iii) and B2ab(iii) criteria. Half of *Magnolia* species in Chiapas occur in protected natural areas, and thus immediate action is required to protect the other four species, *M. faustinomirandae*, *M. mayae*, *M. sharpii* and *M. zamudioi*. Seven out of the eight *Magnolia* species (88%) are not found in ex-situ collections despite being endangered or critically endangered.

**Key words**: *Magnolia guatemalensis, Magnolia hondurensis, Magnolia poasana*, "Tajchack" (Tzeltal language)

## Resumen

Se describe e ilustra una nueva especie de *Magnolia* del Parque Nacional Lagunas de Montebello, de la Altiplanicie o Macizo Central de Chiapas, México. *Magnolia montebelloensis* pertenece a la sección *Magnolia*; difiere de *M. poasana* por su hábito de menor tamaño, entrenudos distales, estípulas y brácteas espatáceas densamente pubescentes, entrenudos pedunculares más cortos y mayor número de estambres. Se incluye una clave, una evaluación ecológica y de conservación para las ocho especies de Magnoliaceae de Chiapas. *Magnolia montebelloensis* crece en bosque mesófilo de montaña y se compara con otras especies de *Magnolia* de Chiapas según sus preferencias de vegetación y clima. Fue evaluada como en peligro crítico (CR) según los criterios B1ab(ii,iii) y B2ab(iii) de la UICN. La mitad de las especies de *Magnolia* de Chiapas se encuentran en áreas naturales protegidas, por lo que se sugiere acción inmediata para proteger las cuatro especies restantes, *M. faustinomirandae, M. mayae, M. sharpii* y *M. zamudioi*. Siete de las ocho especies de *Magnolia* (88%) no se encuentran en colecciones ex situ a pesar de estar en peligro o en peligro crítico.

**Palabras clave**: *Magnolia guatemalensis*, *Magnolia hondurensis, Magnolia poasana*, Parque Nacional Lagunas de Montebello, "Tajchack" (Lengua Tzeltal)

*Accepted by Mark Chase: 5 Oct. 2017; published: 17 Nov. 2017*

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## Introduction

*Magnolia* diverged from *Liriodendron* (both Magnoliaceae s.l.) over 100 million years ago (Romanov & Dilcher 2013). Originating in North America, ancestral Magnoliaceae migrated to Europe and Asia and later became extinct in Europe and western North America. The family then migrated south, resulting in its current bicontinental American-Asian pattern (Hebda & Irving 2004).

Despite numerous phylogenetic studies of Magnoliaceae in the last two decades, their classification remains controversial. For example, taxonomic recognition of the number of sections (0–11), genera (1–13), subgenera (0–9) and subfamilies (1–2) is far from reaching a consensus (Law 1984, Figlar & Nooteboom 2004, Xia *et al*. 2008, Sima *et al.* 2008, Kim & Suh 2013, Romanov & Dilcher 2013). Here we follow the classification of Figlar & Nooteboom (2004), consisting of only two genera: *Liriodendron* Linnaeus (1753: 535) with only two species, and a broad concept of *Magnolia* Linnaeus (1753: 535) including all other species.

Magnoliaceae include nearly 350 species, half of them in the Americas (Vázquez-García *et al.* 2016), from southern Ontario in Canada to the Mata Atlántica in Paraná, Brazil, south of the Tropic of Capricorn. In temperate Asia, they occur in the eastern Himalayas, China, Manchuria, Japan and Taiwan. Also in tropical Asia, they are present in India, Thailand, Vietnam, Malaysia, and Indonesia, growing from near sea level to 3400 m in elevation. Many species have been described in the last decade, and therefore the current number of described species does not match the former *World Checklist of Magnoliaceae* (Frodin & Govaerts 1996) or the former IUCN Red List of Magnoliaceae (Cicuzza *et al.* 2007); conversely, this figure is closer to the IUCN Red List addendum of Rivers *et al.* (2016) or the introduction to Neotropical Magnoliaceae by Vázquez-García *et al.* (2016).

Mexico and Central America currently include 54 species of *Magnolia,* 27 species in sect. *Talauma* Jussieu (1789: 281) Baillon (1866: 66), 22 in sect. *Magnolia,* and five species in section *Macrophylla* Figlar & Nooteboom (2004: 92). In terms of absolute species richness, Mexico is the richest country in the region with ca. 40 species of *Magnolia*, followed by Costa Rica (11), Panamá (8), Guatemala (6), Honduras (6), Nicaragua (2), Belize (1) and El Salvador (1). Although political boundaries do not reflect biogeographic units, we have nonetheless used them, given the small size of most Central American countries and the lack of local biogeographic studies to have a general view of the broad patterns of the species of interest. Thus, we have found that the family displays a remarkable pattern of allopatric speciation in the area, with only seven species (12%) shared between two or more countries (Vázquez-García 1990, 1994, Vázquez-García *et al*. 2002, 2012a, 2012b, 2012c, 2013a, 2013b, 2013c, 2013d, 2016, Jiménez-Ramírez & Cruz 2005, Jiménez-Ramírez *et al*. 2007, Cruz *et al*. 2008).

Molecular analyses using five DNA regions (De Castro *et al*. pers. comm.), three plastid (*matK*, *psbA* and ORF 350) and two nuclear (GAI & PHYA) have indicated: a) *M. montebelloensis* belongs indeed to sect. *Magnolia*; b) this species is clearly unrelated to the well supported "northern Mesoamerican" subclade including *M. guatemalensis* (Guatemala), *M. yoroconte* (Honduras), and species from the Mexican Sierra Madre del Sur such as *M. vazquezii* (Guerrero), *M. iltisiana* (Jalisco) and *M. pacifica* (Jalisco); and c) its relationships to other species are still unresolved.

Magnoliaceae of Chiapas currently include eight species of *Magnolia* (Fig. 1), two of them in section *Talauma*: *M. lacandonica* Vázquez, Pérez-Farrera & Martínez-Camilo (Vázquez-García *et al*. 2013a: 31), and *M. perezfarrerae* Vázquez & Gómez (Vázquez-García *et al*. 2013c: 3); and six in section *Magnolia*: *M. faustinomirandae* Vázquez (Vázquez-García *et al*. 2013: 463), *M. mayae* Vázquez & Pérez-Farrera (Vázquez-García *et al*. 2012b: 109), *M. sharpii* Miranda (Miranda 1955: 79), an unnamed species from Motozintla and the Tacaná Volcano, *M. zamudioi* Vázquez (Vázquez-García *et al*. 2013d: 484) and the one proposed here as new, which has been previously referred to as *Magnolia aff. poasana* (Pittier) Dandy (Pittier 1910: 93, Dandy 1927: 263, Breedlove 1986, Vázquez-García 1994, Vázquez-García *et al*. 2012b).

Breedlove (1986) in his floristic checklist of Chiapas cited 10 specimens as "*Magnolia poasana vel aff.*", the specimens from four municipalities, Jitotol, Ocosingo, La Independencia and La Trinitaria. However, *Magnolia poasana vel aff.* has not been confirmed in Mexico or northern Central America, but rather is considered native to Costa Rica and Panamá (Váquez-García 1990, 1994). Two of the collections by Breedlove (*Breedlove 35173* and *35273*) were treated by Vázquez-García (1990, 1994) as "*Magnolia aff. yoroconte"* and here are listed as paratypes of the proposed new species. In 2012, five of those ten specimens (*Breedlove 47403*, *48410*, *49505*, *57776* & *56209*) were cited as paratypes of the recently described *M. mayae* (Vázquez-García *et al.* 2012b) and in 2013 another specimen (*Breedlove & Keller 49350*) was selected as the holotype of the newly described *M. faustinomirandae* Vázquez (Vázquez-García *et al.* 2013d: 462). Attendance at the Mexican Congress of Botany held in Chiapas in 2013 was a great opportunity to visit local herbaria in Chiapas and carry out field work at Lagunas de Montebello National Park, in the Municipality of

La Trinitaria, where Breedlove first collected specimens from populations of this species more than half a century ago. The hirsute spathaceous bract was a distinctive feature not present in any of the closely related taxa, *M. poasana* or *M. hondurensis* Molina (Molina 1974: 95). Additionally, images of other specimens at CAS shed light on the variability of the species, which made it possible to eventually contrast it with related taxa (Table 1). We then concluded that we were dealing with an undescribed species. Here we describe and illustrate *Magnolia montebelloensis*, a new species from section *Magnolia*, endemic to the Lagunas de Montebello National Park.

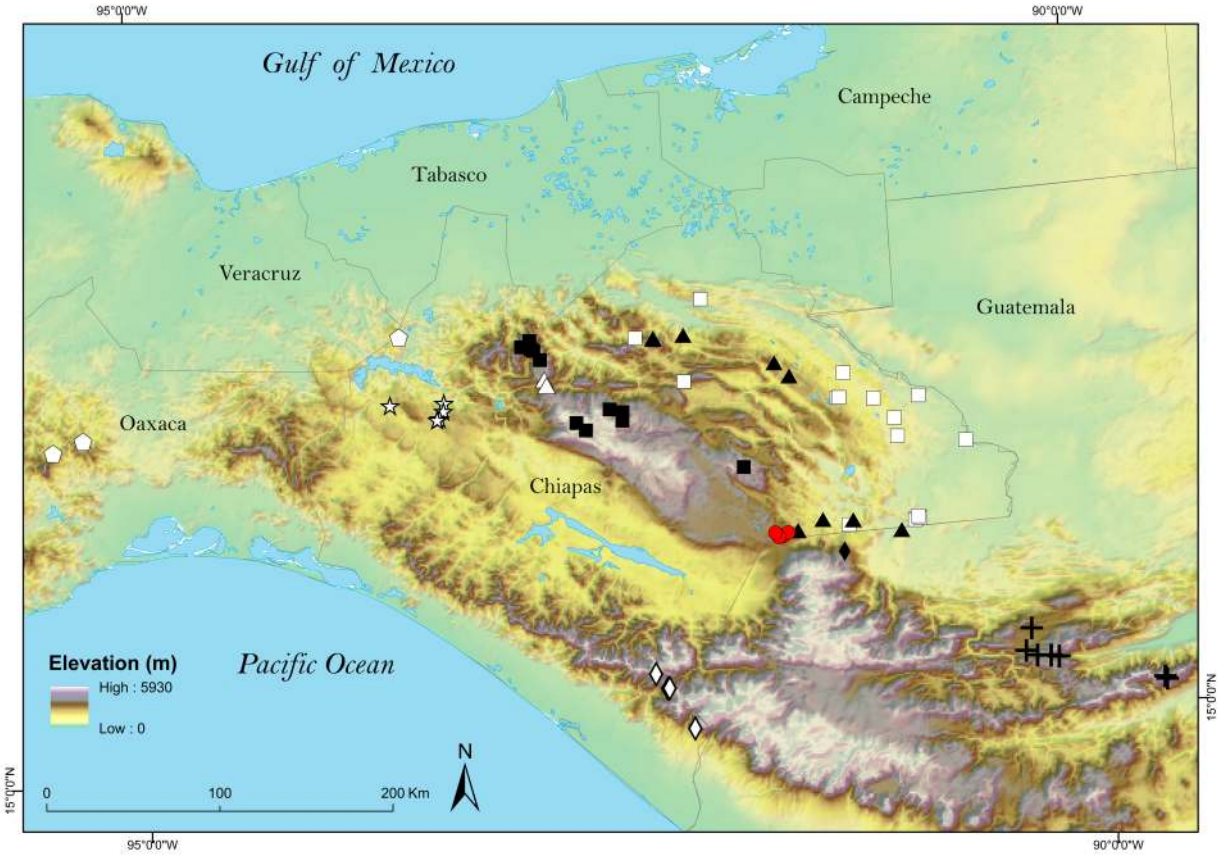


**FIGURE 1.** Distribution of *Magnolia montebelloensis* and other species of *Magnolia* from Chiapas and Oaxaca (Mexico) and Guatemala. Section *Magnolia*: red solid circles: *M. montebelloensis*; solid black squares: *M. sharpii*; solid black triangles: *M. mayae*; solid white rhombuses: unnamed *Magnolia*; solid white triangles: *M. faustinomirandae*; pentagons: *M. zamudioi*; crosses: *M. guatemalensis* Donnell Smith (1909: 253); section *Talauma*: solid white squares: *M. lacandonica*; stars: *M. perezfarrerae*; solid black rhombus: *M. steyermarkii* Vázquez (Váquez-García *et al.,* 2012c: 122).

**TABLE 1.** Differences between *Magnolia montebelloensis, M. hondurensis* and *M. poasana*

| | ***Magnolia montebelloensis*** | ***Magnolia hondurensis*** | ***Magnolia poasana*** |
|---|---|---|---|
| Tree height (m) | 12–16(–24) | 10–20 | (15–)20–30 |
| Color of staminophore | reddish | brown | brown |
| Leaf size (cm) | (9.0–)15.3–20.2(–22.2) × (3.5–)6.6–8.5(–10.8) | 10.0–18.0 × 4.4–8.0 | 8.0–12.0 × 4.0–6.0 |
| Abaxial leaf surface | glabrous | ferruginous pubescent | glabrous |
| Distal/youngest internodes | glabrescent to densely pubescent | densely pubescent | glabrous |
| No. of spathaceous bracts | 3 | 1 | 2 |
| Pubescence of spathaceous bracts | densely covered with long golden yellowish hairs | densely covered with long golden yellowish hairs | glabrous |
| Stamens | (53–)60–66(–85) | 61–93 | 50–52(–54) |
| No. of carpels | (22–)24–34(–35) | 23–38 | 24–26 |
| Carpel indumentum | pubescent | pubescent | glabrous |
| Petiole length (cm) | (2.3–)3.2–3.4(–4.0) | 1.5–2.5 | 1.5–2.6 |
| Length (cm) of largest peduncular internode in mature polyfollicles | 1.0–1.5 | 2.3–2.5 | 3.0–4.0 |

***Magnolia montebelloensis*** A.Vázquez & Pérez-Farr., *sp. nov*. (Figs. 1–4)

Type:—MEXICO. Chiapas: Municipio La Trinitaria, km 4, road from Tsikaw [Tziscao] to Colonia Cuauhtémoc, Paraje Dos Lagos, 16°05'32.7" N, 91°38'12.9" W, 1452 m, 26 Oct 2013, in cloud forest, *Vázquez-García 10109* (fl, fl bud, fr) (holotype: IBUG!; isotypes BIGU!, CR!, HEM!, MEXU!).

*Magnolia montebelloensis* is similar to *M. poasana* from Costa Rica in having fruits of similar size with somewhat beaked carpels. However, it differs from the latter in height, 12–16(–24) vs. 25–30 m, distal twig internodes pubescent to glabrescent vs. glabrous, stipules pubescent vs. glabrous, three densely hairy spathaceous bracts vs. two and glabrous, length of the largest peduncular internode 1.0–1.5 vs 3.0–4.0 cm, number of stamens (53–)60–66(–85) vs. 50–52(–54), and carpels pubescent vs. glabrous.

Evergreen trees, 12–16(–24) m tall, 20–35 cm dbh; twigs 0.6–0.9 cm width; twig internodes 1.0–1.6 × 0.6–8.0 cm, lenticellate, terminal internodes glabrescent to densely shiny, yellowish pubescent; petioles (2.3–)3.2–3.4(–4.0) × (0.2–)0.3–0.4 cm, glabrous, without stipular scars; stipules free from the petiole, 7.0–11.1 × 1.2 cm, pinkish, densely pubescent; early leaf buds 0.5–1.1 cm, densely pubescent, leaves oblong lanceolate (9.0–)15.3–20.2(–22.2) × (3.5–) 6.6–8.5(–10.8) cm, adaxially and abaxially glabrous; largest peduncular internodes 1.0–1.5 cm long; flower buds ovoid to oblongoid, consisting of three spathaceous, densely hirsute bracts, with long golden-yellowish hairs, the outermost bract often glabrescent; flowers terminal, solitary, 11 cm in diam., creamy white; sepals 3, 4.2–4.3 × 2.7–2.8 cm, greenish; petals 6, outer ones 5.3–5.4 × 2.6–2.7 cm, obovate, gradually narrowed toward the base, creamy white; inner petals 4.4–4.5 × 2.0–2.3 cm, obovate, creamy white, fragrant; staminophore (0.65–)0.80–0.90 × 0.60–0.80 cm, reddish; stamens(53–)60–66(–85), laminar, creamy yellowish, reddish at base, the connective obtuse to acute, strongly arched; stigmas 0.3–0.4 cm, curled and filiform, beaked, mostly persistent, tan to brownish; fruit oblongoid (3.5–)5.4–6.3 × 2.5–2.7(–3.4) cm, yellowish to reddish, glabrescent to pubescent; carpels (22–)24–34(–35), acute at the apex and with curled, persistent stigmas, the beaks 0.4–0.5 cm, pubescent to glabrescent; seeds 1–2 per carpel, 0.9–1.0 × 0.8 cm, scarlet red.

**Eponymy**:—This species is named after the Lagunas de Montebello National Park, the type locality.

**Distribution and habitat**:—Endemic to the Lagunas de Montebello Region, Municipality of La Trinitaria, in eastern Chiapas, Mexico, in the physiographic province Sierras de Chiapas y Guatemala, subprovince Altos de Chiapas (INEGI 2004), (Fig. 1, Table 2). Only known from five solitary trees on roadsides at the edge of pasturelands on gentle slopes between Tziscao and Colonia Cuauhtémoc and from another collection locality at Cinco Lagos, at 1300–1600 m. According to data from the meteorological station in Tziscao (16.1° N, 91.63° W; 1475 m) the mean annual temperature is 17.3° C, mean annual precipitation 2279 mm and mean annual evaporation 948 mm. The climate of the region is humid temperate with a long cool summer and abundant rains, which is referred to as (Cb(m)(f)ig), according to García & CONABIO (1998) and García (2004). More than 10.2% of precipitation falls during the winter. The climate is isothermal (less than 5° C of annual oscillation of monthly mean temperatures) of a Ganges type. The region is covered by a Lower Cretaceous limestone that gave rise to the formation of a karstic lake complex of more than 50 lakes, which includes solution lakes with dolines (Hutchinson 1957), uvalas and poljes (Alcocer *et al.* 2016). The dominant soil types on the *M. montebelloensis* location records are luvisol profondic-humic, umbrisol humic-endoleptic and infertile luvisol cromic-dystric, with intermediate texture (INEGI 2013).

*Magnolia montebelloensis* is said to be a rare species that is found scattered in the forest (pers. comm., Joel Hernández-Morales from Ejido Tziscao, 26 October 2013). This species inhabits the Chiapas Montane Forests ecoregion (Olson *et al.* 2001), in montane rain forest (*sensu* Breedlove 1981), subtropical wet forest (*sensu* Holdridge 1967) or bosque mesófilo de montaña (*sensu* Rzedowski 1978), growing with *Malmea* sp., *Parathesis belizensis, Podocarpus matudae, Liquidambar styraciflua*, *Cornus* sp., and *Saurauia* sp. It is to be expected on the Guatemalan side and the Maya Mountains in Belize.

None of the other seven *Magnolia* species in Chiapas has the same elevational range as *M. montebelloensis* except for *M. faustinomirandae* (Table 2), but the latter receives less annual precipitation (1705–1918 vs. 2295–2754 mm). Los Altos de Chiapas Mountain (the central Chiapas Highlands; 1600–2884 m) has served as a partial geo-ecological barrier between both species (Fig. 1), contributing to the observed allopatric pattern. The isolation of these two species generated by this mountain chain should have been greater during the long cool periods of Pleistocene glaciations, since these two species are likely more sensitive to frost than *Magnolia sharpii*, which is the species best adapted to the colder climatic regime of the highest mountains of the central Chiapas Highlands (Fig. 1, Table 2).

There are two *Magnolia* species in section *Magnolia* that are geographically close to *M. montebelloensis*: *Magnolia mayae* and *M. sharpii,* but the habitat conditions that both face are different to those of *M. montebelloensis*. *Magnolia mayae* prefers the warmer and wetter Lacandonian tropical rainforest conditions, unlike the cooler habitat of *M. montebelloensis* (Table 2), and competes with tall tropical rainforest trees, which are absent in the montane forests

of *M. montebelloensis*. *Magnolia sharpii* prefers colder and less rainy conditions (Table 2), where night frosts are frequent from December to April (Wolf 2005), whereas the Montebello Lakes region has no frosts (Ramírez-Marcial *et al.* 2010).

**FIGURE 2.** *Magnolia montebelloensis.* A. Tree, standing at the base Miguel Muñiz & Antonio Vázquez. B. Stipule on late leaf bud. C. Leaves. D. Flower bud with spathaceous bract and early axillary leaf buds. E–F. Flowers forced open with and without stamens, respectively. G. Flower after male phase. H. Developing gynoecium, with axillary leaf buds. I. Developing fruit. Photographs by Antonio Vázquez, A–C & I from *Vázquez-García et al. 10107*; & D–H, from the holotype.

**FIGURE 3.** *Magnolia montebelloensis.* A–F. Fruit maturation to dehiscence. G–H. Carpels removed to show morphological variability. I. Fruits on the ground. Photographs by Antonio Vázquez, A & E–I from *Vázquez-García et al. 10108*; B–D from *Vázquez-García et al. 10107.*

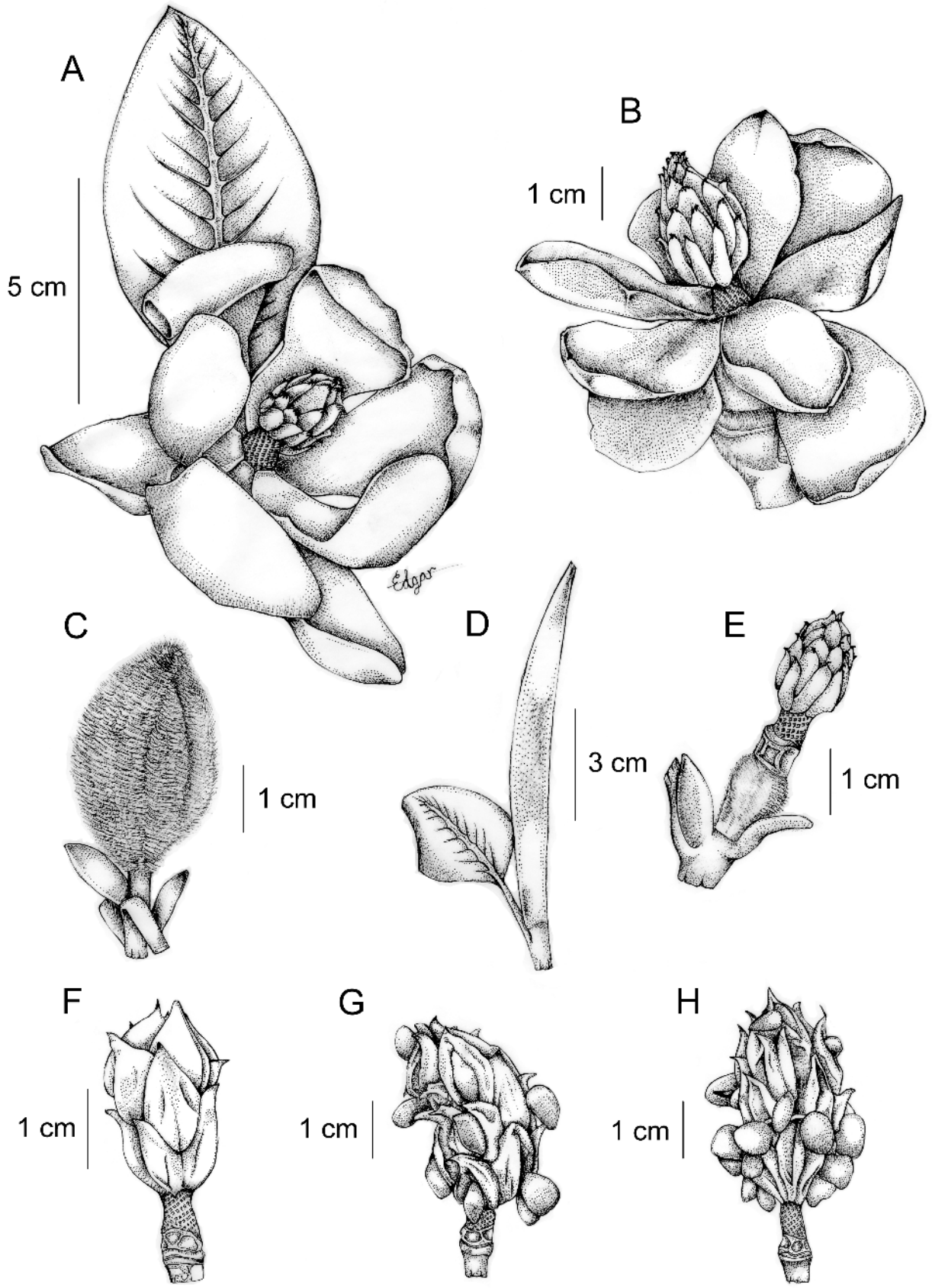


**FIGURE 4.** *Magnolia montebelloensis.* A. Flower after male phase. B. Flower manually forced open with stamens removed. C. Flower bud with densely hirsute spathaceous bract and early vegetative buds. D. Leaf stipule in late vegetative bud. E. Gynoecium with early axillary leaf buds and terminal internode; sepals, petals and stamens removed. F. Developing fruit. G–H. Fruits during dehiscence. Illustration by Esaú Vázquez-Verdejo. A–C & E from the holotype. D, F–G from *Vázquez-García et al. 10107*; H from *Vázquez-García et al. 10108.*

**TABLE 2.** Eco-geographic and climatic characteristics for the Chiapan species of *Magnolia*

| ***Magnolia* species** | **Elevation range (m)** | **Habitat** | **Ecoregion (Olson et al. 2001)** | **Physiographic province (INEGI 2004)/ Distribution** | **Mean annual temperature range (°C) (Hijmans *et al.* 2005)** | **Annual precipitation range (mm) (Hijmans *et al.* 2005)** |
|---|---|---|---|---|---|---|
| *M. montebelloensis* | 1300–1600 | Montane rain forest, *Pinus-Quercus-Liquidambar* forest (*sensu* Breedlove 1981); subtropical wet forest (*sensu* Holdridge 1967); bosque mesófilo de montaña (*sensu* Rzedowski 1978) | Chiapas Montane Forests | Sierras de Chiapas y Guatemala, subprov. Altos de Chiapas/E Chiapas | 19.1–19.8 (17.3 at Tziscao meteorological station) | 2295–2754 (2279 at Tziscao meteorological station) |
| *M. mayae* | 410–1200 | Tropical rain forest, lower montane rain forest, montane rain forest, *Pinus-Quercus-Liquidambar* forest (*sensu* Breedlove 1981); tropical moist forest, subtropical wet forest (*sensu* Holdridge 1967); bosque tropical perennifolio, bosque mesófilo de montaña (*sensu* Rzedowski 1978) | Petén-Veracruz Moist Forests | Sierras de Chiapas y Guatemala, subprov. Sierra Lacandona/E Chiapas, W Guatemala | 19.8–25.8 | 2270–3498 |
| *M. sharpii* | 1650–2409 | Evergreen cloud forest, montane rain forest, *Pinus-Quercus-Liquidambar* forest (*sensu* Breedlove 1981); warm temperate moist/wet forest (*sensu* Holdridge 1967); bosque mesófilo de montaña (*sensu* Rzedowski 1978) | Central American Pine-Oak Forests, Chiapas Montane Forests | Sierras de Chiapas y Guatemala, subprov. Sierras del Norte de Chiapas, Altos de Chiapas/N & Central Chiapas | 13.6–17.4 | 1203–2175 |
| *M. faustinomirandae* | 1420–1793 | Montane rain forest, *Pinus-Quercus-Liquidambar* forest (*sensu* Breedlove 1981); subtropical/warm temperate moist forest (*sensu* Holdridge 1967); bosque mesófilo de montaña (*sensu* Rzedowski 1978) | Chiapas Montane Forests | Sierras de Chiapas y Guatemala, subprov. Sierras del Norte de Chiapas/N Chiapas | 17.5–20.3 | 1705–1918 |
| *M. zamudioi* | 800–1080 | Lower montane rain forest, montane rain forest, *Pinus-Quercus-Liquidambar* forest, tropical rain forest (*sensu* Breedlove 1981); subtropical moist/wet forest (*sensu* Holdridge 1967); bosque mesófilo de montaña, bosque tropical perennifolio (*sensu* Rzedowski 1978) | Oaxacan Montane Forests, Petén-Veracruz Moist Forests | Sierras de Chiapas y Guatemala, subprov. Sierras del Norte de Chiapas/W Chiapas; Sierra Madre del Sur, subprov. Sierras Orientales/E Oaxaca, NW Chiapas | 19.2–24.0 | 1210–2602 |
| *M. sp.* | 1628–2095 | Montane rain forest, *Pinus-Quercus-Liquidambar* forest (*sensu* Breedlove 1981); warm temperate/subtropical moist/wet forest (*sensu* Holdridge 1967); bosque mesófilo de montaña, (*sensu* Rzedowski 1978) | Sierra Madre de Chiapas Moist Forests, Central American Pine-Oak Forests | Cordillera Centroamericana, subprov. Volcanes de Centroamérica y Sierras del Sur de Chiapas/S Chiapas | 14.9–18.7 | 1295–2635 |
| *M. lacandonica* | 150–1200 | Tropical rain forest, lower montane rain forest (*sensu* Breedlove 1981); tropical/subtropical moist forest (*sensu* Holdridge 1967); bosque tropical perennifolio, (*sensu* Rzedowski 1978) | Petén-Veracruz Moist Forests, Chiapas Montane Forests | Sierras de Chiapas y Guatemala, subprov. Sierra Lacandona, Sierras del Norte de Chiapas/E & N Chiapas | 22.7–25.8 | 1808–3434 |

*...continued on the next page*

**TABLE 2.** (Continued)

| *Magnolia* species | Elevation range (m) | Habitat | Ecoregion (Olson et al. 2001) | Physiographic province (INEGI 2004)/ Distribution | Mean annual temperature range (°C) (Hijmans *et al.* 2005) | Annual precipitation range (mm) (Hijmans *et al.* 2005) |
|---|---|---|---|---|---|---|
| *M. perezfarrerae* | 433–820 | Tropical rain forest, lower montane rain forest, evergreen seasonal forest (*sensu* Breedlove 1981); subtropical moist forest (*sensu* Holdridge 1967); bosque tropical perennifolio, bosque tropical subcaducifolio (*sensu* Rzedowski 1978) | Petén-Veracruz Moist Forests | Sierras de Chiapas y Guatemala, subprov. Altos de Chiapas/W Chiapas | 22.7–24.5 | 914–1163 |

**Phenology:**—Flowering April–June, occasional flowers throughout the year; fruiting September–November.

**Ethnobotany**:—No uses have been recorded for this species, which is locally known as "tajchack" (in the Tzeltal language).

**Conservation status**:—Trees are being spared because they are considered rare. The assigned category of this species is critically endangered (CR). Despite the legal protection afforded to the Lagunas de Montebello National Park (LMNP), global warming, frequent severe fires, high incidence of tropical insect pests and agricultural expansion are seriously threatening this species with extinction. Conservation status of *Magnolia montebelloensis* was evaluated using the B1ab(ii,iii) and B2ab(iii) criteria of the IUCN Red List Categories and Criteria (IUCN 2012).

B1a: The known extent of occurrence (EOO) for this species was determined using a combined technique of areographic analysis (Rapoport & Monjeau 2001) and the minimum convex polygon method (IUCN 2012), the latter traced around the circular buffer areas that surround the record points of the species, for which radii were equal to the average of the minimum distances between pairs of record points of the species (mean propinquity index). The EOO of *M. montebelloensis* was estimated as an area of approximately 49.5 km$^2$. The area of extent of occurrence of *M. montebelloensis* is severely fragmented by agricultural and pasture lands, human settlements and high frequency of wildfires outside and even inside the Lagunas de Montebello National Park. An example was the severe fires (canopy fires) of 1998 that damaged 50% of the National Park area and deforested about 30% of the land (CONANP 2006, March & Flamenco, 1996). Many remnant individuals of its population are found as isolated trees in a matrix of pasturelands and croplands. Another threat to *M. montebelloensis* is the increase in the use and pollution of water resources of the Montebello Lakes, due to increased human population in the vicinity and wastewater discharges from the city of Comitán into Río Grande, which discharges into Lake Tepancoapan, the largest of the Montebello Lakes (CONANP 2007). *Magnolia montebelloensis* is highly dependent upon the quantity and quality of the water in the lakes.

B1b(ii, iii): The extent and quality of the montane rain forest of the LMNP region, the habitat of *M. montebelloensis,* has been reduced continuously since 1970. That year the National Park had 71.98% of its forest in good condition (CONANP 2007). By 1993, 61.39% of the park had been reduced to disturbed or fragmented cloud forests and 10% of disturbed or fragmented temperate forests, with only 264 ha in good condition (SARH 1994). By 1995 the transformed or disturbed areas covered more than 50% of the total area and by 2005 only 4707 ha of a total of 6425 ha were forest area, and of these 44% was disturbed or secondary growth forests.

B2ab(iii): The area of known occupancy (AOO) of the species was estimated to measure approximately 8.7 km$^2$ because the EOO polygon has more than 80% of its area occupied by agricultural and pasturelands, human settlements and lakes. Only approximately 42% (20.7 km$^2$) of the EOO is inside the "protected" LMNP, of this ca. 3.5 km$^2$ are lakes, 10.2 km$^2$ agriculture or pastures and 0.8 km$^2$ human settlements, resulting in only 6.2 km$^2$ of "protected" montane forest habitat for *M. montebelloensis*. Outside the protected LMNP, the situation is even worse, and only small fragments of secondary montane forest remain, which in total cover no more than 2.5 km$^2$. The total known AOO of *M. montebelloensis* is approximately 8.7 km$^2$.

All magnolias of Chiapas are narrow endemics, mostly confined to Chiapas, except for *M. mayae*, which is found in both sides of the Mexican-Guatemalan border, and *M. zamudioi*, which also is found in eastern Oaxaca (Fig. 1, Tables 2 and 3). Six (75%) out of the eight species of *Magnolia* from Chiapas are critically endangered (Table 3), and the other two are endangered. There are three Chiapan *Magnolia* species that are highly restricted, *M. montebelloensis, M. faustinomirandae* and an unnamed species from the Tacaná volcano (Fig. 1, Table 3), all of them matching the critically endangered category of the IUCN Red List.

Half of the Chiapan magnolias occur in protected natural areas, and thus immediate action is suggested to protect the other four species, *M. faustinomirandae*, *M. mayae*, *M. sharpii* and *M. zamudioi* (Table 3). Seven out of the eight *Magnolia* species (88%) are not found in ex-situ collections despite being endangered or critically endangered (Table 3).

In recent decades, in the face of the partial collapse of the traditional agricultural economy and the absence of alternatives in Chiapas, the rural population has elected to ensure their survival in the short term rather than adopting strategies for long-term development (Peláez-Herreros 2012). This means that the rural human populations of Chiapas still need to make intensive use of their natural resources, such as logging for wood, firewood and charcoal for their basic needs (Ghilardi *et al.* 2007, Baroody 2013) or convert land to extensive agriculture or pasturelands (Castillo-Santiago *et al.* 2007). As long as the causes of lags in sustainable development and economic deficiencies remain in rural areas of Chiapas, it will be difficult to stop or reverse deforestation, and this will keep the species of *Magnolia* in critical danger of extinction.

**TABLE 3.** Conservation assessment of the eight Chiapan *Magnolia* species. Supplemented and updated from González-Espinosa *et al*. 2011, Vázquez-García *et al*. 2012b, 2013a, 2013d, Rivers *et al.* 2016.

| ***Magnolia* species** | **Proposed IUCN Red List Category and Criteria** | **Red list assessment following IUCN criteria (IUCN 2012)** | ***In situ* conservation in Protected Natural Areas (PNA)** | ***Ex situ* conservation** |
|---|---|---|---|---|
| *M. montebelloensis* | Critically Endangered (CR): B1ab(ii, iii) B2ab(ii, iii) | The Extent of Occurrence (EOO) is an area of approximately 49.5 km$^2$ and the Area of Occupancy (AOO) of the species is *ca.* 8.7 km$^2$, they are severely fragmented by agricultural and pasture lands, human settlements and high frequency of wildfires outside and even inside the Lagunas de Montebello National Park (LMNP). The extent and quality of the montane rain forest have been reduced continuously since 1970. By 2005 only 4,707 ha of a total of 6,425 ha of the LMNP were forest area, and of these, 44% was disturbed or secondary growth forests (CONANP 2007). | This species occurs only in one PNA, its area of occupancy inside the Lagunas de Montebello National Park is *ca*. 6.5 km$^2$ and no more than 2.5 km2 outside: Even worse, this species is rare inside and outside the Park. | There are no ex situ collections for this species. |
| *M. mayae* | Critically Endangered (CR): C2a(i); D | Its EOO (minimum convex polygon) is an area of *ca.* 14,000 km$^2$, but its AOO is *ca.* 4,081 km$^2$, its forest habitat is severely fragmented and is declining due to logging and the rapid expansion of pasturelands, agriculture, coffee plantations and human settlements, except in Montes Azules Biosphere Reserve. These threats are likely to continue as the area is favorable for pasturelands and agriculture. The extent and quality of the lower montane rain forest in its EOO has been reduced continuously since 1970 (Vazquez-García *et al*. 2012b, 2013d). *Magnolia mayae* is only known from eight localities in Chiapas, Mexico, and one in Guatemala (Vazquez-García *et al.* 2013b). Population size is small, fewer than 25 individuals are known, with 12 or fewer adult individuals (Rivers *et al.* 2016). | It is not known to occur in any PNA. It may occur in Montes Azules Biosphere Reserve and the Nahá and Cascadas de Agua Azul PNAs. | There are no ex situ collections for this species (Rivers *et al.* 2016). |
| *M. sharpii* | Endangered (EN) B1ab(iii,v) | Its EOO is 2,228 km$^2$, its cloud forest habitats are severely fragmented and degraded and it is known from eleven locations (Rivers *et al.* 2016). The forests have been impacted mainly by wood extraction, clearance for agriculture, cattle grazing and fire. Genetic analyses with isozymes indicated large variation within its populations and low genetic differentiation between them. Other results suggest inbreeding in its populations (González-Espinosa *et al*. 2011). | It is not known to occur in any PNA. It may occur in Rancho Nuevo, Bosque de Coníferas Chanal, Huitepec-Los Alcanfores and El Recreo Chiapan State PNAs, and the private Biotic Reserve Gertrude Duby. | There was at least one *ex situ* collection in the country of origin and there were four in other countries (BGCI 2008). There are seven *ex situ* collections (Rivers *et al.* 2016). |
| *M. faustinomirandae* | Critically Endangered (CR): B1ab(iii) | This species is only known from two localities at municipality of Jitotol, Chiapas. The known extent of occurrence (EOO) is less than 100 km². Deforestation rates are high, with the habitat declining continuously. Research into the distribution and legal protection for this species is urgently needed. Its habitat is severely fragmented. No other collections have been made for over three decades (Vazquez-García *et al*. 2013d). | It is not known to occur in any PNA. There is no PNA with montane rain forest close to its populations. | There are no ex situ collections for this species (Rivers *et al.* 2016). |

*...continued on the next page*

**TABLE 3.** (Continued)

| *Magnolia* species | Proposed IUCN Red List Category and Criteria | Red list assessment following IUCN criteria (IUCN 2012) | *In situ* conservation in Protected Natural Areas (PNA) | *Ex situ* conservation |
|---|---|---|---|---|
| *M. zamudioi* | Endangered (EN): B1ab(iii) B2ab(iii) | Only known from from two populations: one in eastern Oaxaca (Guevea de Humboldt y Lachiguxe localities) and one in northwestern Chiapas (Cerro Mono Pelón,Tecpatán), both areas featuring a severely fragmented montane rainforest and isolated in a big matrix of pastures, secondary growth and tropical rain forests. Oaxacan population has an EOO of ca. 828.9 km$^2$ and an AOO of ca. 220 km$^2$, Chiapan population has a very restricted EOO of 1.75 km$^2$ and an AOO of ca. 0.63 km$^2$.Legal protection for populations in Tecpatán, Chiapas and Oaxaca are urgently needed, before they are lost (Vazquez-García *et al.* 2013d). | It is not known to occur in any PNA. There is not any PNA with montane rain forest or tropical rain forest close to its populations. | There are no ex situ collections for this species. (Rivers *et al.* 2016). |
| *M.* sp. (unnamed) | Critically Endangered (CR): B1ab(iii) | It is currently known from only one locality in the southwestern slope of Tacaná Volcano, being that the populations of the three previous collection localities of Motozintla region have been exterminated by deforestation and land use change for agriculture and pasture lands. | It occurs only in the Tacaná Volcano Biosphere Reserve and the neighbouring Tacaná Volcano Chiapan State PNA. It may occur in Cordón Pico El Loro-Paxtal Chiapan State PNA. | There are no ex situ collections for this species. The Universidad de Guadalajara has begun trials to propagate this species. |
| *M. lacandonica* | Critically Endangered (CR): C2a(i) | Its total extent of occurrence (EOO) is approximately 13,000 km². Its forest habitat is severely fragmented and continues declining due to logging and the rapid expansion of pasturelands, agriculture and human settlements, except in the Montes Azules Biosphere Reserve (Vázquez-García *et al*. 2013a, 2013d). The known population consist of fewer than 250 mature individuals and the largest subpopulation consists of 13 mature trees The number of mature individuals is declining (Rivers *et al*. 2016). The wood of this tree is highly valued by local people. There was a single adult tree at the type locality and two adult trees at the Misolhá Waterfall, both under protection (Vázquez-García *et al*. 2013b). | Several trees are protected at the Chajul Tropical Biological Station (UNAM), in Montes Azules Biosphere Reserve. According to their EOO other PNAs where *M. lacandonica* might occur are: Lakantún Biosphere Reserve Bonampak, Yaxchilán, Nahá, Metzabok y Cascadas de Agua Azul. | There are no ex situ collections for this species (Rivers *et al.* 2016). |
| *M. perezfarrerae* | Endangered (EN): B1ab(i,ii,iii) | Its EOO is *ca.* 600 km², but the current threats include the transformation of their habitat to coffee and corn plantations as well as for pasturelands. This species has extremely reduced populations apparently without regeneration (Vázquez-García *et al*. 2013a, 2013c, 2013d). Although population numbers are not known from the entire range, the population is thought to be small with only ten mature trees present at the type locality. There is some local cultivation (Rivers *et al.* 2016). | This species inhabits only one PNA: the Selva del Ocote Biosphere Reserve. It might occur in the neighboring La Pera Chiapan State PNA. | There are no ex situ collections for this species. (Rivers *et al.* 2016). The El Colegio de la Frontera Sur (ECOSUR) in Chiapas has begun trials to propagate this species. |

**Additional specimens examined:—**MEXICO. Chiapas: Municipio La Trinitaria, Lago Tziscao on the border with Guatemala, 30 mi E of La Trinitaria, 4500 ft [ca. 1372 m], 14 Apr 1965 (fl bud, fl), *Breedlove 9743* (CAS); La Trinitaria, Lago Tsiskaw on the Guatemala border, 30 mi E of La Trinitaria, 4500 ft [ca. 1372 m], 27 May 1965 (fl, young gynoecium), *Breedlove 1066* (CAS); La Trinitaria, E of Laguna Tziscao, Monte Bello National Park, 16 Nov 1972 (fl bud, fr), 1300 m, *Breedlove & Dressler, 29606* (CAS); La Trinitaria, E of Laguna Tziscao, Monte Bello National Park, 23 Jan 1973 (fl bud, fr), 1300 m, *Breedlove & Smith 32252* (CAS); La Trinitaria, Laguna Tziscao, Monte Bello National Park, 1300 m, 13 May 1973 (fl, young gynoecium), *Breedlove 35173* (CHIP); La Trinitaria, Laguna Tziscao, Monte Bello National Park, 1300 m, 13 May 1973 (sterile), *Breedlove 35273* (CAS, CHIP); La Trinitaria, near Cinco Lagos, Lagos de Monte Bello National Park, 1372 m, 5 Oct 1981 (fr), *Breedlove 53334* (CAS); La Trinitaria, Col. Cuauhtémoc, N side of the road, 10 Jun 1984 (fl bud, fl), *Méndez G. (Alush Shilon Ton) 7656* (CHIP); La Trinitaria, Cinco Lagunas, Lagos de Monte Bello National Park, 1600 m, 24 May 1988 (sterile), *Breedlove 68649* (CAS); La Trinitaria, E of Laguna Tziscao, Monte Bello National Park, 6 Jul 1988 (sterile), *Vázquez-García et al. 4645* (WIS); La Trinitaria, Ejido Tziscao, 16°05'11.8"N, 91°38'58.6W", 1465 m, 26 Oct 2013 (fr), *Vázquez-García et al. 10107* (BIGU, CR, HEM, IBUG, MEXU); La Trinitaria, km 3, Tziscao to Benito Juárez, 16°05'21"N, 91°38'34.9"W, 1455 m, 26 Oct 2013 (fl bud, fr), *Vázquez-García et al. 10108* (BIGU, CR, HEM, IBUG, MEXU).

**Key to the species of Magnoliaceae in Chiapas**

1. Petioles with long stipular scar; schistosyncarp with circumcissile dehiscence (*Magnolia* sect. *Talauma*, subsect. *Talauma*) ..... 2
- Petioles with stipular scar absent or not evident; polyfollicle with dorsal dehiscence (*Magnolia* sect. *Magnolia*) ..... 3
2. Abaxial portions of carpels detaching from fruit axis and falling mostly in large irregular many-carpellate masses; fruit broadly ovoid to ellipsoid; carpels 89–92, slightly humped; stamens 175–179, Selva Zoque ..... *M. perezfarrerae*
- Abaxial portions of carpels detaching from fruit axis and falling singly; fruits broadly ovoid to subglobose; carpels 61–70 (80), non-humped; stamens 198–248, Selva Lacandona ..... *M. lacandonica*
3. Mature polyfollicles densely pubescent, 7.0–12.0 (15.0), 3.0–5.0 (5.3) cm in diam. ..... 4
- Mature pollyfollicles glabrous to glabrescent, 3.0–6.0 (–7.0) cm long, 2.0–3.7 (4.4) cm in diam. ..... 5
4. Leaf blades cuneate, narrowly obovate, shortly and abruptly acuminate, glabrous; carpels 42–57; stamens 95–97 (Chiapas and Guatemala) ..... *M. mayae*
- Leaf blades broadly obovate to ovate, obtuse at the apex, abaxially with shortly appressed pubescence; carpels 85–99 (–100), stamens 220–240 ..... *M. sharpii*
5. Fruits 2.5–3.4 cm in diam, carpels 22–40 ..... 6
- Fruits 1.7–2.5 cm in diam, carpels 14–20 ..... 7
6. Carpels (22–)24–34(–35), stamens (53–)60–66(–85) ..... *M. montebelloensis*
- Carpels 36–40, stamens 100–120 ..... *M. faustinomirandae*
7. Fruit ellipsoid, carpels 18–20 (Motozintla and Tacaná) ..... *M.* sp.
- Fruits subglobose, carpels 14–18 ..... *M. zamudioi*


## Acknowledgements

We acknowledge Juan and Joel Hernández-Morales from Ejido Tziscao, La Trinitaria, Chiapas, for allowing us to collect on their property. José and Eliseo Juan-Vázquez, Marta E. González-Villegas and Quetzalcóatl Vázquez-González helped us during fieldwork. We thank the curators of relevant herbaria (CAS, CHIP, HEM, MEXU), particularly Debra Trock, Collections Manager at CAS for facilitating digital images of most of the cited specimens collected by Breedlove and his colleagues. We thank Esau Vázquez-Verdejo for the illustration of this species. ESG gratefully acknowledges support from Autonomous University of Guadalajara, JAVG & MAMC thank the University of Guadalajara-CUCBA, CONACyT-SNI and PRODEP-SEP in Mexico for their support.


## References


Alcocer, J., Oseguera, L.A., Sánchez, G., González, C.G., Martínez, J.R. & González, R. (2016) Bathymetric and morphometric surveys of the Montebello Lakes, Chiapas. Proceedings of the 6th National Congress of Limnology. *Journal of Limnology* 75: 56–65. https://doi.org/10.4081/jlimnol.2016.1343

Baillon, H.E. (1866) Mémoire sur la famille des Magnoliacées. *Adansonia* 7: 1–16, 65–69.

Baroody, J.J. (2013) *Firewood extraction as a catalyst of pine-oak forest degradation in the Highlands of Chiapas, Mexico.* Master in science dissertation, University of Washington.

BGCI (2008) *Global survey of ex situ Magnoliaceae collections*. Botanical Gardens Conservation International, Richmond UK. Available from: http://www.bgci.org/files/Worldwide/global_survey_of_ex_situ_magnoliaceae_collections.pdf (accessed 7 September 2017)

Breedlove, D.E. (1981) *Flora of Chiapas, part I: introduction to the Flora of Chiapas.* California Academy of Sciences, San Francisco, 33 pp.

Breedlove, D.E. (1986) *"Flora de Chiapas IV" Listados florísticos de México.* Instituto de Biología, UNAM, México, 246 pp.

Castillo-Santiago, M.A., Hellier, A., Tipper, R. & De Jong, B.H.J. (2007) Carbon emissions from land-use change: an analysis of causal factors in Chiapas, Mexico. *Mitigation and Adaptation Strategies for Global Change* 12: 1213–1235. https://doi.org/10.1007/s11027-006-9060-7

CONANP (2006) *Mapa de Zonificación del Parque Nacional Lagunas de Montebello.* Escala 1:54,000. Departamento de Sistemas y Análisis Geográfico, Región Frontera Sur, Tuxtla Gutiérrez, México.

CONANP (2007) *Programa de Conservación y Manejo Parque Nacional Lagunas de Montebello.* Secretaría de Medio Ambiente y Recursos Naturales. Comisión Nacional de Áreas Naturales Protegidas. Secretaría del Medio Ambiente y Recursos Naturales. México, D. F.

Cruz, D.R., Vega, F.K. & Jiménez-Ramírez, J. (2008) *Magnolia vazquezii* (Magnoliaceae), una especie nueva del estado de Guerrero, México. *Novon* 18: 21–24. https://doi.org/10.3417/2005096

Dandy, J.E. (1927) The genera of Magnolieae. *Bulletin of Miscellaneous Information Kew* 1927: 263–264. http://doi.org/10.2307/4107601

Donnell-Smith, J. (1909) Undescribed plants from Guatemala and other Central American republics. *The Botanical Gazette* 47: 253. https://doi.org/10.1086/329872

Figlar, R.B. & Nooteboom, H.P. (2004) Notes on Magnoliaceae IV. *Blumea* 49: 87–100. http://doi.org/10.3767/000651904X486214

Frodin, D.G. & Govaerts, R. (1996) *World checklist and bibliography of Magnoliaceae*. Royal Botanic Gardens, Kew.

García, E. & Comisión Nacional para el Conocimiento y Uso de la Biodiversidad [CONABIO] (1998) *'Climas' (clasificación de Köppen, modificado por García).* Escala 1:1000000. México.

García, E. (2004) *Modificación al sistema de clasificación climática de Köppen (Adaptado para la República Mexicana).* Instituto de Geografía. Universidad Nacional Autónoma de México, México, D.F., 90 pp.

Ghilardi, A., Guerrero, G. & Masera, O. (2007) Spatial analysis of residential fuelwood supply and demand patterns in Mexico using the WISDOM approach. *Biomass and Bioenergy* 31: 475–491.

Hebda, R.J. & Irving, E. (2004) On the origin and distribution of magnolias: tectonics, DNA and climate change. *In: Timescales of the Paleomagnetic Field, Geophysical Monograph Series 145.* American Geophysical Union, Washington DC, 57 pp.

Hijmans, R.J., Cameron, S.E., Parra, S.E., Jones, P.G. & Jarvis, A. (2005) Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology* 25: 1965–1978. https://doi.org/10.1002/joc.1276

Holdridge, L.R. (1967) *Life zone ecology, revised edition.* Tropical Science Center, San José.

Hutchinson, G.E. (1957) *A treatise on limnology: geography, physics, and chemistry, pt. 1. Geography and physics of lakes (vol. 1).* Wiley, New York, 1015 pp.

INEGI (2004) *Conjunto de Datos Vectoriales Fisiográficos. Continuo Nacional.* Escala 1:1'000,000. Serie I. INEGI (2013) Carta edafológica Serie II 1:250000, Las Margaritas E-15-12 D15-3. México, D.F.

IUCN (2012) *IUCN Red List Categories and Criteria: Version 3.1.* Second edition. IUCN, Gland & Cambridge, 32 pp.

Jiménez-Ramírez, J. & Cruz, D.R. (2005) *Magnolia krusei* (Magnoliaceae), una especie nueva de Guerrero, México. *Novon* 15: 438–441.

Jiménez-Ramírez, J., Vega, F.K., Cruz, D.R. & Vázquez-García, J.A. (2007) *Magnolia guerrerensis* (Magnoliaceae), una especie nueva del bosque mesófilo de montaña del estado de Guerrero, México. *Boletín de la Sociedad Botánica de México* 80: 73–76.

Jussieu, A.L. (1789) *Genera plantarum 1.* Herrisant, Paris, 498 pp.

Kim, S. & Su, Y. (2013) Phylogeny of Magnoliaceae based on ten chloroplast DNA regions. *Journal of Plant Biology* 56: 290–305. https://doi.org/10.1007/s12374-013-0111-9

Law, Y.W. (1984) A preliminary study on the taxonomy of the family Magnoliaceae. *Acta Phytotaxonomica Sinica* 22: 80–109.

Linnaeus, C. (1753) *Species plantarum*. Salvius, Stockholm. 560 pp.

March, I.J., & Flamenco, A. (1996). *Evaluación rápida de la deforestación en las áreas naturales protegidas de Chiapas (1970-1993)*. Informe técnico para TNC y USAID. El Colegio de la Frontera Sur, San Cristóbal de las Casas, México, 123 pp.

Miranda, F. (1955) Dos nuevas especies de árboles del sur de México. *Anales del Instituto de Biología de la Universidad Nacional Autónoma de México* 26: 79–87.

Molina-Rossitto, A. (1974) Una contribución de varias plantas nuevas en América Central. *Ceiba* 18: 95–106.

Olson, D.M., Dinerstein, E., Wikramanayake, E.D., Burgess, N.D., Powell, G.V.N., Underwood, E.C., D'Amico, J.A., Itoua, I., Strand, H.E., Morrison, J.C., Loucks, C.J., Allnutt, T.F., Ricketts, T.H., Kura, Y., Lamoreux, J.F., Wettengel, W.W., Hedao, P. & Kassem, K.R. (2001) Terrestrial ecoregions of the world: a new map of life on Earth. *Bioscience* 5: 933–938. https://doi.org/10.1641/0006-3568(2001)051[0933:TEOTWA]2.0.CO;2

Peláez-Herreros, Ó. (2012) Análisis de los indicadores de desarrollo humano, marginación, rezago social y pobreza en los municipios de Chiapas a partir de una perspectiva demográfica. *Economía, Sociedad y Territorio* 12: 181–213. https://doi.org/10.22136/est00201290

Pittier, H. (1910) New or noteworthy plants from Colombia and Central America-2: Magnoliaceae: the Costa Rican species of *Talauma*. *Contributions from the United States National Herbarium* 134: 93–132.

Rapoport, E.H. & Monjeau, J.A. (2001) Areografía. *In:* Llorente, J. & Morrone, J. (Eds.) *Introducción a la biogeografía en Latinoamérica: teorías, conceptos, métodos y aplicaciones*. Facultad de Ciencias, UNAM, Mexico City, pp. 23–30.

Ramírez-Marcial, N., González-Espinosa, M., Camacho-Cruz, A. & Ortiz-Aguilar, D. (2010) Forest restoration in Lagunas de Montebello National Park, Chiapas, Mexico. *Ecological Restoration* 28: 354–360. https://doi.org/10.3368/er.28.3.354

Rivers, M., Beech, E., Murphy, L. & Oldfield, S. (2016) *The Red List of Magnoliaceae (revised and extended)*. Botanic Gardens Conservation International, Richmond, UK.

Romanov, M.S. & Dilcher, D.L. (2013) Fruit structure in Magnoliaceae s.l. and *Archaeanthus* and their relationships. *American Journal of Botany* 100: 1494–1508.
https://doi.org/10.3732/ajb.1300035

Rzedowski, G. (1978) *Vegetación de México.* Limusa, México, 432 pp.

SARH (1994) *Inventario nacional forestal periódico 1992–1994*. Subsecretaría Forestal y de Fauna Silvestre. México, D.F.

Sima, Y.K. & Lu, S.G. (2009) [2012] A new system for the family Magnoliaceae. *In*: *Proceedings of the second international symposium on the family Magnoliaceae*. Huazhong University Science Technical Press, Wuhan, pp. 55–71.

Vázquez-García, J.A. (1990) *Taxonomy of the genus* Magnolia *(Magnoliaceae) in Mexico and Central America.* M.S. Thesis. University of Wisconsin-Madison, 224 pp.

Vázquez-García, J.A. (1994) *Magnolia* (Magnoliaceae) in Mexico and Central America: a synopsis. *Brittonia* 46: 1–23.
https://doi.org/10.2307/2807454

Vázquez-García, J.A., Carvajal, S. & Hernández-López, L. (2002) *Magnolia pugana* (Magnoliaceae): una nueva combinación en el complejo *M. pacifica. Novon* 12: 137–141.
https://doi.org/10.2307/3393253

Vázquez-García, J.A., De Castro-Arce, E., Muñiz-Castro, M.A. & Cházaro-Basáñez, M.J. (2012a) *Magnolia zoquepopolucae* (subsection *Talauma*, Magnoliaceae), a new species from Sierra de Santa Marta, Veracruz, Mexico. *Phytotaxa* 57: 51–55.
https://doi.org/10.11646/phytotaxa.57.1.7

Vázquez-García, J.A., Pérez-Farrera M.A., Martínez-Meléndez N., Nieves-Hernández G. & Muñiz-Castro M.A. (2012b) *Magnolia mayae* (Magnoliaceae), a new species from Chiapas, México. *Botanical Sciences* 90: 109–112.
https://doi.org/10.17129/botsci.478

Vázquez-García, J.A., Muñiz-Castro, M.A., De Castro-Arce, E., Murguía-Araiza, R., Nuño-Rubio, A.T. & Cházaro-Basáñez, M.J. (2012c) Twenty new Neotropical tree species of *Magnolia* (Magnoliaceae). *In*: Salcedo-Pérez, E., Hernández-Álvarez, E., Vázquez García, J.A., Escoto-García, T. & Díaz-Echavarría, N. (Eds.) *Recursos forestales del occidente de México: diversidad, manejo, aprovechamiento y conservación. Vol. 4 (Tomo 1).* Serie Fronteras de Biodiversidad. Universidad de Guadalajara CUCEI-CUCBA, Guadalajara, pp. 91–130.

Vázquez-García, J.A., Pérez-Farrera, M.A., Martínez-Camilo, R. Muñiz-Castro, M.A. & Martínez-Meléndez, N. (2013a) *Magnolia lacandonica* (subsection *Talauma*, Magnoliaceae), a new rainforest species from Chiapas, Mexico. *Phytotaxa* 79: 30–36.
https://doi.org/10.11646/phytotaxa.79.1.2

Vázquez-García, J.A., Véliz-Pérez, M.E., Tribouillier-Navas, E. & Muñiz-Castro, M.A. (2013b) *Magnolia quetzal* and *Magnolia mayae*, a new species and a new record, respectively, for the flora of Guatemala. *Phytotaxa* 76: 1–6.
https://doi.org/10.11646/phytotaxa.76.1.1

Vázquez-García, J.A., Gómez-Domínguez, H., López-Cruz, A, Espinosa-Jiménez, J.A., Sahagún-Godínez, E. & Muñiz-Castro, M.A. (2013c) *Magnolia perezfarrerae* a new species and a key to Mexican species of *Magnolia* section *Talauma* subsection *Talauma* (Magnoliaceae). *Botanical Sciences* 91: 1–9.

Vázquez-García, J.A., Muñiz-Castro, M.A., Arroyo, F., Pérez, Á.J., Serna, M., Cuevas-Guzmán, R., De Castro-Arce, E. & Gurrola-Díaz, C.M. (2013d) Novelties in Neotropical *Magnolia* and an addendum proposal to the IUCN Red List of Magnoliaceae. *In*: Salcedo-Pérez, E., Hernández-Álvarez, E., Vázquez García, J.A., Escoto-García, T. & Díaz-Echavarría, N. (Eds.) *Recursos forestales del occidente de México: diversidad, manejo, aprovechamiento y conservación. Vol. 4 (Tomo 2).* Serie Fronteras de Biodiversidad, Universidad de Guadalajara CUCEI-CUCBA, Guadalajara.

Vázquez-García, J.A., Neill, D.A., Asanza, M., Pérez, Á.J. Arroyo, F., Dahua-Machoa, A. & Merino-Santi, R.E. (2016) *Magnolias de Ecuador: en riesgo de extinción*. Universidad Estatal Amazónica, Universidad de Guadalajara-CUCBA, Pontificia Universidad Católica de Ecuador, Universidad Nacional Agraria La Molina, Puyo, ECUADOR, 128 pp.

Wolf, J.H. (2005) The response of epiphytes to anthropogenic disturbance of pine-oak forests in the highlands of Chiapas, Mexico. *Forest Ecology and Management* 212: 376–393.

Xia, N.H., Liu, Y.H. & Nooteboom, H.P. (2008) Magnoliaceae. *In*: Wu, Z.Y., Raven, P.H. & Hong, D.Y. (Eds.) *Flora of China, vol. 7.* Science Press/Missouri Botanical Garden Press, Beijing/St. Louis, pp. 73–75.