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Research article

Populus primaveralepensis sp. nov. (Salicaceae, Malpighiales), a new species of white poplar from the Bosque La Primavera Biosphere Reserve in western Mexico

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Abstract. *Populus primaveralepensis* A.Vázquez, Muñiz-Castro & Zuno sp. nov., a new species from relict gallery cloud forest in Bosque La Primavera Biosphere Reserve (Mexico), is described and illustrated. The new species belongs to *P.* subsect. *Tomentosae* Hart., and is morphologically similar to *P. luziarum* A.Vázquez, Muñiz-Castro & Padilla-Lepe, but differs from it in having taller trees without root suckers, white and ringed young stems and branches, a branching angle of ca 45°, leaves with higher blade to petiole ratio, leaf frequently elliptic or ovate to widely ovate (vs widely ovate to ovate-deltoid), denser inflorescences, and shorter capsules. The conservation status of the species was assessed as Critically Endangered (CR).

Keywords. Mexico, *Populus luziarum*, *Populus simaroa*, *Populus* sect. *Aigeiros*, Salicaceae.

Vázquez-García J.A., Muñiz-Castro M.Á., Martínez-González R.E., Nieves-Hernández G., Pulido-Ávila M.G., Hernández-Vera G. & Zuno Delgadillo O. 2019. *Populus primaveralepensis* sp. nov. (Salicaceae, Malpighiales), a new species of white poplar from the Bosque La Primavera Biosphere Reserve in western Mexico. *European Journal of Taxonomy* 498: 1–16. <https://doi.org/10.5852/ejt.2019.498>

Introduction

The genus *Populus* L. (Salicaceae Mirb., Malpighiales Juss. ex Bercht. & J. Presl) consists of 30 species (aspens, cottonwoods, and poplars) of fast growing and deciduous trees and shrubs, with a boreal to subtropical distribution, and with a great ecological and economical importance (Eckenwalder 1996; Vázquez-García *et al.* 2017). In Mexico, the genus currently comprises ten species, belonging to four sections: *P.* sect. *Abaso* Eckenw., *P.* sect. *Aigeiros* Duby, *P.* sect. *Populus*, and *P.* sect. *Tacamahaca* Spach (Eckenwalder 1977a, 1977b; Rzedowski 1985; Vázquez-García & Cuevas-Guzmán 1989; Martínez-González & González-Villarreal 2002, 2005; Vázquez-García *et al.* 2017). Five species are reported from western and southern Mexico, one belonging to *P.* sect. *Aigeiros*: *P. fremontii* subsp. *mesetae* Eckenw., from northern Jalisco and the region Los Altos (Eckenwalder 1977a, 1977b; Martínez-González & González-Villarreal 2002), and four of them belonging to *P.* sect. *Populus*: *P. guzmanantlensis* A. Vázquez & Cuevas (*P.* subsect. *Tomentosae* Hart.), endemic to the Jaliscan region of the Sierra Madre del Sur (Vázquez-García & Cuevas-Guzmán 1989), *P. luziarum* A. Vázquez, Muñoz-Castro & Padilla-Lepe, endemic to the municipality of Zapopan, Jalisco (Vázquez-García *et al.* 2017), *P. simaroa* Rzed. from the State of Mexico, Guerrero, and Michoacán (Rzedowski 1975), and *P. tremuloides* Michx. (*P.* subsect. *Trepidiae* (Dode) Tamm) recorded from the municipality of Mezquitic, Jalisco (Michaux 1803; Martínez-González & González-Villarreal 2002).

Here, we describe and illustrate a new species of *P.* (sect. *Populus*) subsect. *Tomentosae*, *P. primaveralepis* A. Vázquez, Muñoz-Castro & Zuno sp. nov. growing in relict cloud forest at the Bosque La Primavera Biosphere Reserve (BLPBR) in Jalisco, Mexico.

Material and methods

Populus primaveralepis sp. nov. was first collected at the BLPBR in 2009 from a single small tree, and the specimen was kept at IBUG (Harker *et al.* 4045 leg.). However, it remained cryptic since it was determined and filed in the IBUG herbarium as *P. simaroa* Rzed. Recently, in February 2013, J. Padilla-Lepe, a member of a seed-collecting team at the BLPBR, led by O. Zuno-Delgadillo, found it again, but this time as the dominant canopy tree in the relict gallery cloud forest of the eastern Tala, Jalisco. The biologist J. Padilla-Lepe only collected a single sterile terminal twig, because he thought it was a second locality of *P. luziarum*, a recently described species that he had found a year earlier in western Tesislán, in Zapopan, Jalisco (Vázquez-García *et al.* 2017). A month later (March 2013), A. Vázquez, J. Padilla-Lepe, and O. Zuno-Delgadillo revisited the population for a closer examination, unveiling substantial qualitative and quantitative differences from the latter in the habit (non-soboliferous and taller trees with whitish branches), narrower leaves, and denser male and female inflorescences (Table 1), allowing us to conclude that we were dealing with an undescribed species of *P.* (sect. *Populus*) subsect. *Tomentosae*.

The morphological description and the illustrations are based on fresh and herbarium material. Leaf description and terminology of reproductive structures follow Radford *et al.* (1974), Eckenwalder (2010), and Dickmann & Kuzovkina (2014). The herbarium acronyms follow Thiers (2017). Detailed examination of herbaria type specimens and electronic images of type material for both *P. guzmanantlensis* (holotype: ZEA; isotypes: BRIT, CAS, CHAPA, CIIDIR, ENCB, F, GH, LE, MEXU, MICH; MO, TEX, UAMIZ, WIS) and *P. simaroa* (holotype: ENCB; isotypes: CAS, ENCB, G, MEXU, MICH, MO, NY, OS, P, US), available at the Global Plant JSTOR website (except for the holotype of *P. guzmanantlensis*), allowed us to determine the morphological differences among the taxa (Table 1). For the accepted names we followed POWO (2018). Authors and names of plants follow the IPNI (2018). The conservation status was assessed based on the criteria of IUCN (2012).

Table 1 (page 1 of 2). Differences between *P. primaveralepis* A.Vázquez, Muñiz-Castro & Zuno sp. nov. and morphologically and geographically related taxa in western and southern Mexico, based on herbarium type specimen examinations (Eckenwalder 1977a, 1977b; Martínez-González & González-Villarreal 2002, 2005; Rzedowski 1975, 1985; Vázquez-García & Cuevas-Guzmán 1989; Vázquez-García *et al.* 2017).

Traits	<i>P. primaveralepis</i>	<i>P. luzae</i>	<i>P. tremuloides</i>	<i>P. guzmanantensis</i>	<i>P. fremontii</i> subsp. <i>mesetae</i>	<i>P. simaroa</i>
Habit	non-soboliferous	soboliferous (usually)	soboliferous (usually)	soboliferous (rarely)	soboliferous (usually)	soboliferous (frequently)
Tree height (m)	25–30	15–20	5–15(20)	25–45	6–15(30)	(8)25–45
Tree dbh (m)	0.3–1.2	0.3–1.5	0.1–0.2(0.3)	0.5–1.9	0.2–1.2	(0.3)1.5–2.0
Bark	rarely furrowed, even the tall trees, upper branches white, usually at an angle ca 45°	evidently furrowed, even the middle aged trees, upper branches brown, usually at an angle >75°	smooth to slightly furrowed	smooth when young to longitudinally sulcate	deeply furrowed	deeply furrowed
Petiole						
Length (cm)	2.0–4.2(5.4)	(3.7)4.5–6.0	2.0–8.0	(2.0)4.0–8.0(10.0)	5.0–6.0	2.0–8.0
Shape	laterally compressed at the blade union	barely laterally compressed	laterally compressed at the blade union	cylindrical at the blade union	transversely flattened at blade union	laterally compressed
Pubescence	densely pubescent	glabrous to pubescent	glabrous	pubescent	pubescent	pilose-tomentose
Leaf blade size (cm)	(7.0)9.3–18.5 × (4.5)7–10.2(14.3)	(9.5)10.5–15.0(16.0) × (7.8)8.8–13.4(14.2)	2.5–8.5 × 2.0–8.0	3.0–14.0(16.0) × 5.0–10.0(13.0)	(2.0)4.0–14.0 × 2–8	8.0–23.0 × 5.0–13.0
Leaf shape	elliptic to ovate to widely ovate	widely ovate, to ovate-deltoid	widely ovate to suborbicular	ovate to suborbicular, occasionally rhombic or cordate	broadly deltoid-ovate, trullate at young shoots	ovate-deltoid to rhombic-ovate
Leaf apex	acute	rounded, acute to shortly apiculate	abrupt and acutely acuminate	apiculate 3–15 mm, obtuse or rounded	long-acuminate	acute to acuminate
Leaf base	rounded to subcordate	obtuse to rounded to subcordate	rounded to subcordate	rounded, cordate, obtuse, rarely oblique	truncate to subcordate, cuneate at young shoots	truncate to subcordate
Abaxial leaf surface	pubescent throughout	puberulent, tertiary veins not very prominent	glabrous, glaucous, tertiary veins not prominent	pubescent, tertiary veins very prominent	glabrous, tertiary veins not prominent	densely pubescent, tertiary veins very prominent
Length of mature male inflorescence (mm)	10–70	45–65	38–60(90)	10–30	40–130	10–40
Number of stamens	6–12	9–13	6–18	7–15	30–70	10–18

Table 1 (page 2 of 2).

Traits	<i>P. primaveralepensis</i>	<i>P. luzae</i>	<i>P. tremuloides</i>	<i>P. guzmanantensis</i>	<i>P. fremontii</i> subsp. <i>mesetae</i>	<i>P. simaroa</i>
Male bracteoles	ovate, margin entire and ciliate, dentate at the apex, unlobed, 2.5–3.7 × 1.7 mm long	ovate, scarcely pubescent, margin entire, ciliated, unlobed, 0.7–1.0 mm long	margin with 3–5 lanceolate lobes, ciliated, 2.0 mm long	spathulate, deciduous pubescence, margin dentate to parted, ciliated, 2.0–3.0 mm long	narrowly ovate, margin entire, unlobed, 2.5–3.0 mm long	very variable in shape, margin entire, laciniate to lobed, irregularly ciliated, 1.5–2.0 mm long
Female bracteoles	2.0–3.0 mm long, sparsely denticulate to entire, none lobed, ciliated	2.6–3.2 mm long, with denticles, unlobed, ciliated	3.0–5.0 mm long lobed, non-ciliated	1.2–1.5 mm long evidently lobed, ciliated	6.0–8.0 mm long, narrow.	1.5–2.0 mm long, lobed, ciliated
Mature female inflorescence (mm)	40–80	50–60(80)	40–60	50	40–140	45
Dehiscing carpels						
Number	30–80	(35)75–70(77)	ca 50	70–130	(10)28–30	25–75
Arrangement	dense	sparse	sparse	intermediate	sparse	intermediate
Capsule length (mm) and pubescence	1.0–1.8 × 0.6–0.9, pubescent	2.0–2.5, pubescent	(3.0)6.0–9.0, glabrous	2.0–3.0, glabrous	6.0–10.0, glabrous	4.0–6.0, pubescent
Deciduousness of foliage	winter (Jan.–early Mar.)	at the beginning of autumn	winter	middle summer to autumn (Aug.–Nov.)	winter	summer
Flowering	Aug. to Nov.	Sep. to Nov.	Mar. to May	Aug. to Oct.	Feb. to Apr.	Mar. to Jun.
Fruiting	Oct. to Nov.	Oct. to Jan.	Apr. to Jun.	Oct. to Nov.	Mar. to Jul.	Jun. to Jul.
Habitat	gallery cloud forest	gallery mixed forest with tropical moist and cloud forest elements	<i>Pinus arizonica</i> forest	tropical subdeciduous forest-cloud forest ecotone	oak forests	cloud forest, pine-oak forests
Elevation (m a.s.l.)	1330–1640	1330–1460	2650	400–1250	1750–2300	1500–2500
Mean annual rainfall (mm)	800–1000	900	ca 500	1450–1850	ca 760	ca 670
Geography	Sierra La Primavera, Ameca river basin, Arenal and Tala, Central Jalisco, western Transmexican Volcanic Belt	Nextipac plateau, Santiago river basin, Zapopan, central Jalisco, western Transmexican Volcanic Belt	Alaska, Canadá, EU, N of Mexico, Mexican Plateau including Northern Jalisco	S to SW Jalisco and Colima, Sierra Madre del Sur mountain range (Vázquez-García & Cuevas-Guzmán 1989)	S of New Mexico, Texas and Mexican Plateau, including N of Jalisco (Eckenwalder 1977a, 1977b)	State of Mexico, Guerrero and Michoacán (Rzedowski 1975, 1985)

Results

Class Magnoliopsida Brongn.
Order Malpighiales Juss. ex Bercht. & J.Presl
Family Salicaceae Mirb.
Genus *Populus* L.
Section *Populus*
Subsection *Tomentosae* Hart.

Populus primaveralepis A.Vázquez, Muñiz-Castro & Zuno sp. nov.

[urn:lsid:ipni.org:names:77194127-1](https://nomenclature.ipni.org/urn:lsid:ipni.org:names:77194127-1)

Figs 1–4

Differential diagnosis

Populus primaveralepis sp. nov. is morphologically close to *P. luziarum*, but it differs from the latter in possessing various qualitative and quantitative characters, such as having taller trees with non-soboliferous habit, branching angle of ca 45° with white and ringed bark, and leaves with higher blade to petiole ratio (large leaves with petioles 2.9–3.9 vs 5.4–6 cm long, leaf blades frequently elliptic or ovate to widely ovate vs widely ovate to ovate-deltoid, 17–18.5 vs 15.5–16 cm long, inflorescences dense vs sparse, and shorter capsules, 1.0–1.8 vs 2.0–2.5 mm (Table 1).

Type material

Holotype

MEXICO • fr; Jalisco, Tala, along Río La Lobera, Llano Grande, Reserva de La Biosfera Bosque La Primavera; 20.6° N, 103.6° W; 1604 m a.s.l.; 4 Mar. 2013; J. Antonio Vázquez-García, Padilla-Lepe, and Zuno-Delgadillo 10005 leg.; montane cloud forest relict; IBUG.

Isotypes

MEXICO • Same data as for the holotype; K, MEXU, MO, ZEA.

Etymology

The epithet honors the collective conservation accomplishments at Bosque La Primavera for its twelfth anniversary as a MaB–UNESCO Biosphere Reserve as well as the biologist Jesús Padilla Lepe, a young and enthusiastic botanical explorer graduated from the Universidad de Guadalajara who discovered the species.

Other material examined

MEXICO – Jalisco • ♀ fl buds; Municipio Arenal, Bosque La Primavera, 1.5 km S of Fraccionamiento El Roble; 20°41'48.00" N, 103°37'49.71" W; 1330 m a.s.l.; 25 Oct. 2009; M. Harker *et al.* 4045 leg.; IBUG • st; Municipio Tala, Bosque La Primavera, Llano Grande; 20°39'27" N, 103°37'39" W; 1604 m a.s.l.; 8 Feb. 2012; Padilla-Lepe and Zuno-Delgadillo s.n. leg.; IBUG • ♂ fl; Tala, Arroyo La Lobera; 20°39'27.5" N, 103°37'42.2" W; 1640 m a.s.l.; 5 Nov. 2017; J. Padilla-Lepe, O. Ibararán-Madrigal, and J.J. Padilla-García 252a leg.; IBUG • ♀ fl, fr; same collection data as for preceding, J. Padilla-Lepe, O. Ibararán-Madrigal, and J.J. Padilla-García 252b leg.; IBUG • ♂ fl; Acequia, in the SE margin of the town of Tala, intersection at El Álamo, 1 km before the Higher Technological Institute of Tala; 20°38'33.56" N, 103°41'52.18" W; 1332 m a.s.l.; 18 Aug. 2013; Vázquez-García *et al.* 10106b leg.; IBUG • ♀ fl, fr; same collection data as for preceding; Vázquez-García *et al.* 10106c leg.; IBUG • ♂; same collection data as for preceding; 2 Oct. 2017; Vázquez-García and Padilla-Lepe 10150 leg.; IBUG • ♀ fl, fr; same collection data as for preceding; Vázquez-García and Padilla-Lepe 10151 leg.; IBUG • ♂ fl; Municipio de Tala, Arroyo La Lobera 3.5 km E del Macrolibramiento; 20°39'18.64" N,

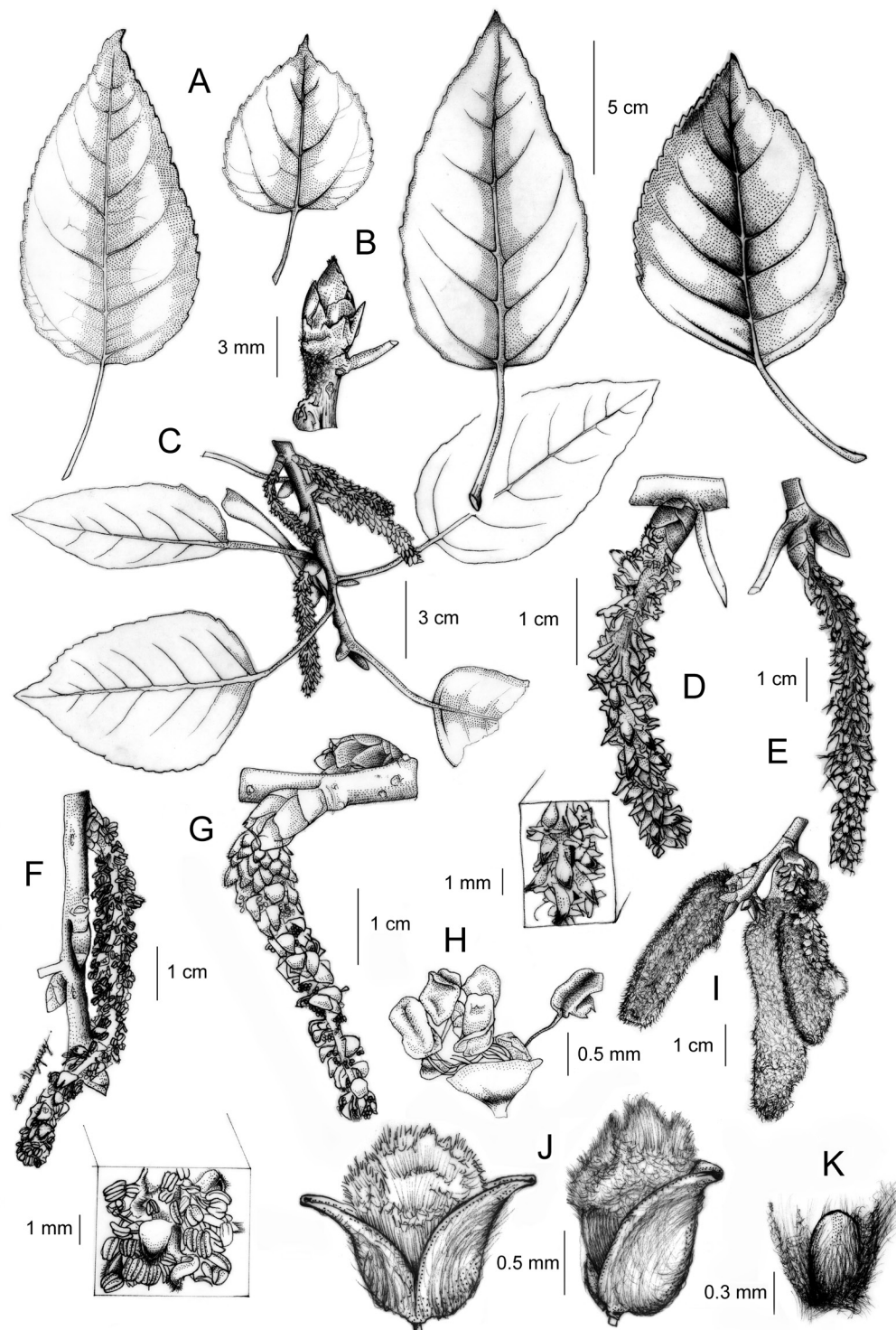


Fig. 1. *Populus primaveralepensis* A.Vázquez, Muñiz-Castro & Zuno sp. nov. **A–E, I–K.** Vázquez-García *et al.* 10106c leg., IBUG. **F–H.** Vázquez-García *et al.* 10106b leg., IBUG. **A.** Variability of leaves. **B.** Leaf bud. **C.** Branch with female inflorescence. **D–E.** Early and late state of inflorescence. **F–G.** Late and early male inflorescence. **H.** Male flower. **I.** Infructescence with pappus. **J.** Capsule complete and in half, with pappus. **K.** Developing gynoecium. Illustrations: E. E. Vázquez-Verdejo.



Fig. 2. *Populus primaveralepensis* A.Vázquez, Muñiz-Castro & Zuno sp. nov. Tree showing its habit and bark. J. Padilla Lepe, standing next to the tree; photograph: O. Ibararán.

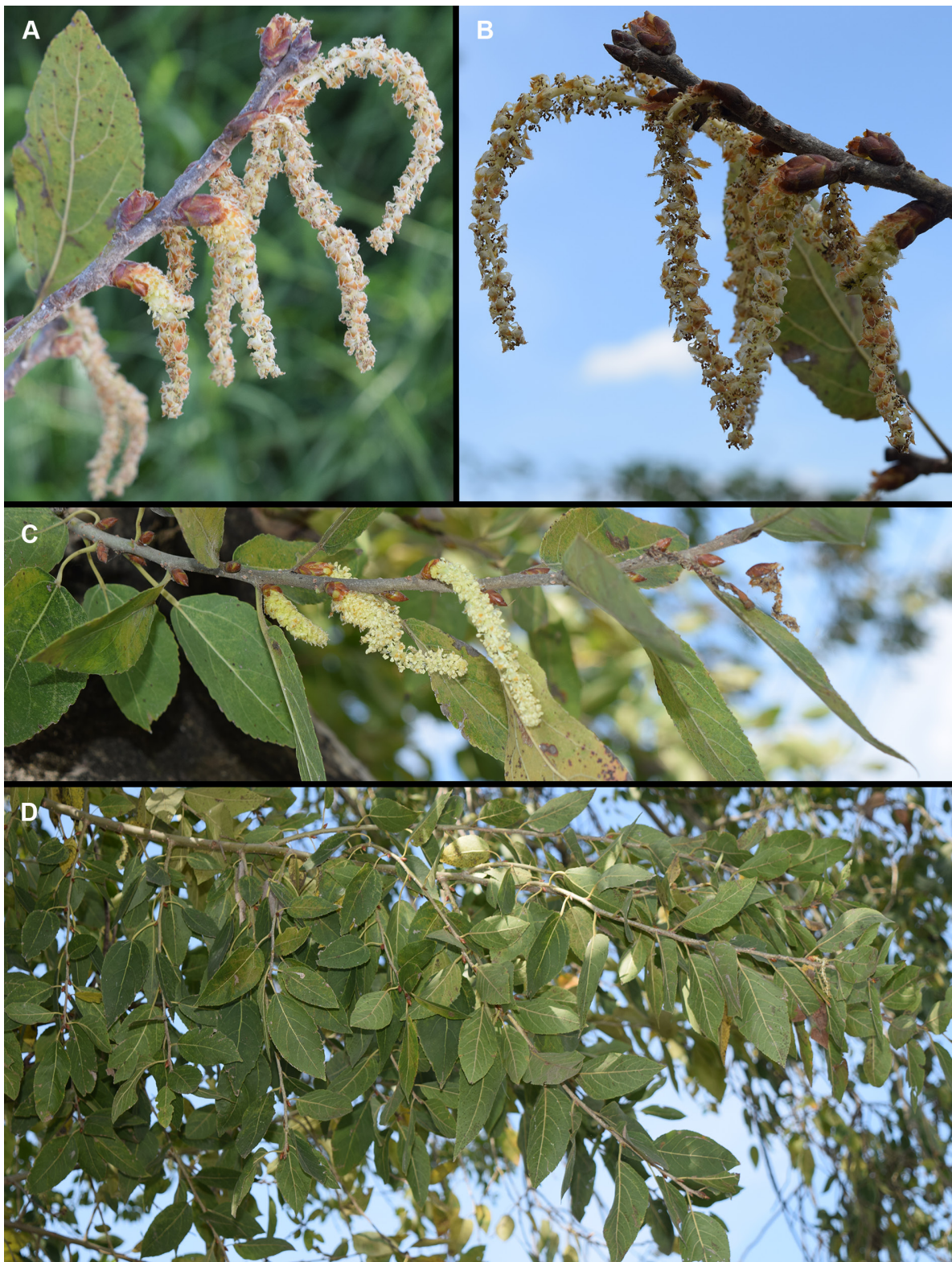


Fig. 3. *Populus primaveralebensis* A.Vázquez, Muñiz-Castro & Zuno sp. nov., male individual, Vázquez-García *et al.* 10106b leg., IBUG. **A–B.** Two views of same branch with inflorescence past anthesis. **C.** Inflorescence at anthesis. **D.** Branch showing leaf variability and venation. Photographs: A. Vázquez.

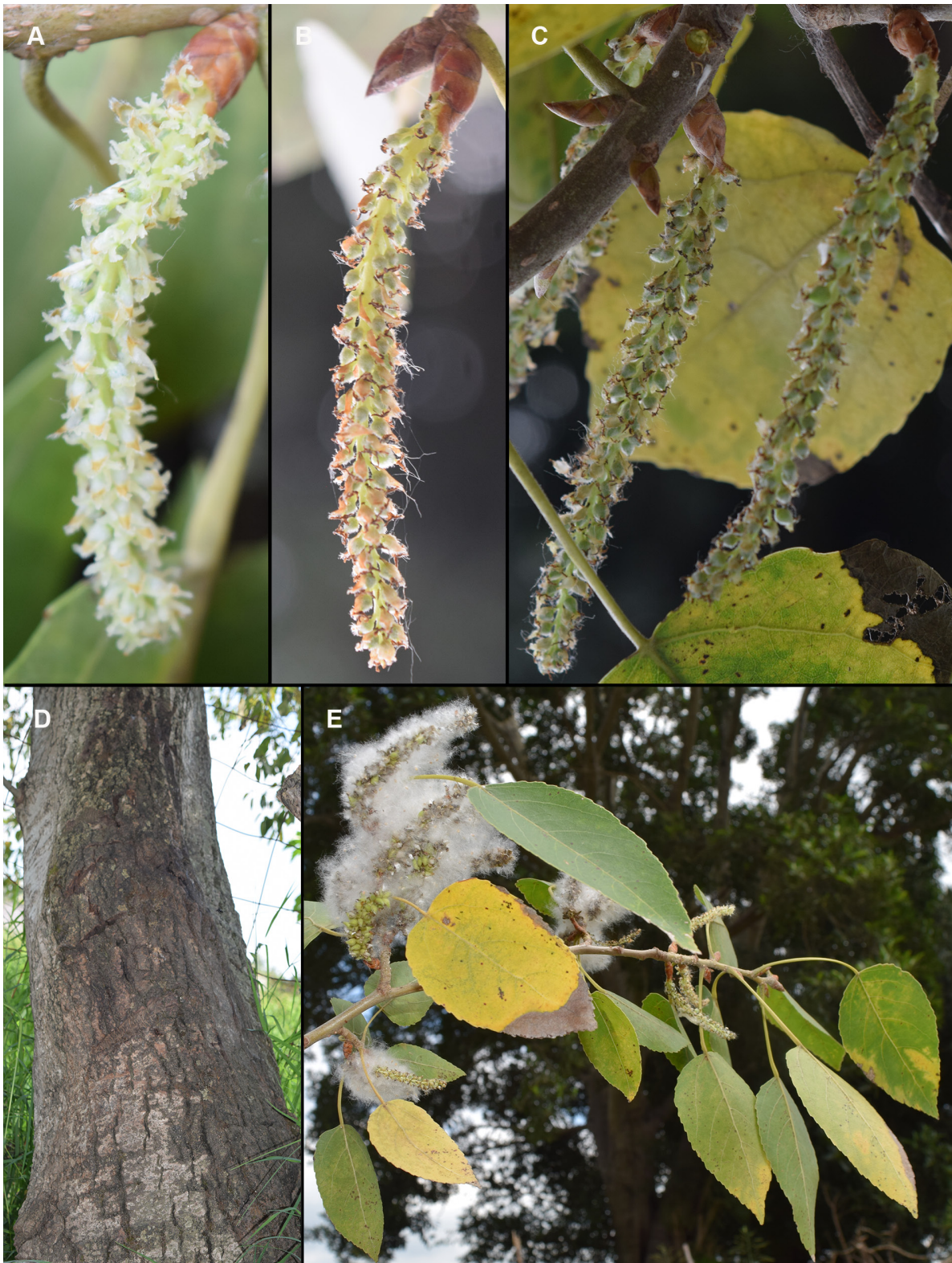


Fig. 4. *Populus primaveralepis* A.Vázquez, Muñiz-Castro & Zuno sp. nov., female individual, Vázquez-García *et al.* 10106c leg., IBUG. **A.** Inflorescence at anthesis. **B.** Inflorescence past anthesis. **C.** Developing infructescence. **D.** Trunk. **E.** Branch with leaves and dehiscing capsules, showing the whitish pappus of seeds. Photographs: A. Vázquez.

103°38'56.54" W; 1427 m a.s.l.; 31 Oct. 2017; H. Luquín-Sánchez and G. Nieves-Hernández s.n. leg.; IBUG • ♀ fl, fr; same collection data as for preceding; 20°39'17.28" N, 103°39'7.25" W; 1439 m a.s.l.; H. Luquín-Sánchez and G. Nieves-Hernández s.n. leg.; IBUG.

Description

Trees 5–30 m tall; trunk 0.3–1.2 m in diameter at breast height, branched or single stemmed; spreading exclusively by seeds (non-soboliferous); bark smooth and whitish at sapling stage, and upper branches occasionally becoming shallowly furrowed and never tessellated. Petioles 2.0–4.2(5.4) cm long, flattened near the leaf union, densely pubescent. Leaf blades (7.0)9.3–18.5 × (4.5)7–10.2–(14.3) cm, elliptic to ovate to widely ovate, rounded to subcordate at the base and acute at the apex, abaxially and densely pubescent throughout. Bud of the male inflorescence 5–7 × 2–3 mm, bright reddish brown, glabrescent, with 6 scales. Male ament 10–70 × 10–25 mm, cylindrical, pendulous and curved, with densely arranged flowers; rachis 1.0–1.5 mm thick, creamy to white, brown when it dries, glabrous; pedicels 0.5–1.5 mm long, greenish; bracteoles 2.5–3.7 × 1.7 mm, ovate, with margin entire and ciliate, unlobed, dentate at the apex, reddish brown. Staminate flowers 48–50, 1.5–2.2 mm long, pedicellate; pedicels 0.3–0.5 mm long; floral disc 1.0–1.2 in diameter, meniscoid, shallow cup, shaped to patelliform, oblique, creamy, brown yellowish when it dries; stamens 6–12, free; filaments 0.5–0.7 mm long, glabrous; anthers 0.6–1.5 × 0.5–0.8 mm, pale yellow, basifix and oblong, longitudinal dehiscence, with tectae 0.6–1.5 × 0.2–0.3 mm. Bud of the female inflorescence 6–15 × 3–5 mm; scales 6–7, 1–5 × 2–6 mm, brown reddish, glabrescent. Female ament 40–80 mm, cylindrical, dense; rachis 1.0–1.5 mm width; pedicels 0.5–1.5 mm long, greenish-yellow color, brown when it dries, sparsely ciliate; bracteoles 2–3 × 1–2 mm, narrowly ovate to elliptic to broadly spatulate, with margin sparsely denticulate to entire, non-lobed, ciliate, caducous, greenish yellow at anthesis, brown-reddish when it dries. Pistillate flowers 30–80, 1.0–1.5 mm long, glabrous; pedicel 0.5–1.0 mm; floral disc 1.2–1.8 mm in diameter, ciathiform, scarcely ciliated; ovary inferior, pisiform, pubescent to glabrescent; styles 0.5–2.0 mm long, each branched into curved stigmas. Infrutescence 20–80 × 10–20 mm; rachis 1.0–1.5 mm thick, brown and glabrate; peduncle 1.0–1.2 mm long; brown and glabrate; bracteoles 3.5–4.0 × 1.2–1.8 mm, narrowly ovate to elliptic to broadly spatulate, margin sparsely denticulate to entire, non-lobed, ciliate, caducous, greenish yellow at anthesis, brown-reddish when it dries; capsules 30–80, 1.0–1.8 × 0.6–0.9 mm, bivalved, closed, narrowly ovoid, pubescence translucent; seeds 1–3 per capsule, 0.3–0.7 × 0.2–0.4 mm, creamy yellowish or reddish brown; pappus 4–6 mm long, yellowish brown or white.

Distribution, habitat and phenology

Western Mexico: State of Jalisco, Bosque La Primavera Biosphere Reserve, along the tributaries of Río La Lobera and Río Caliente, in the municipalities of Tala and Arenal, respectively (Fig. 5).

The relict gallery cloud forest includes *Clethra rosei* Britton (Clethraceae Klotzsch), *Ficus insipida* Willd. (Moraceae Gaudich.), *Ilex dugesii* Fernald (Aquifoliaceae Bercht. & J.Presl), *Morella cerifera* (L.) Small (Myricaceae Rich. ex Kunth), *Persea hintonii* C.K. Allen (Lauraceae Juss.), *Prunus serotina* subsp. *capuli* (Cav.) McVaugh (Rosaceae Juss.), *Quercus magnoliifolia* Née and *Quercus gentryi* C.H.Muller (Fagaceae Dumort.), and *Salix taxifolia* Kunth (Salicaceae Mirb.) (Table 1). The flowering occurs from August to November, the fruiting from October to November, and deciduous foliage can be observed during winter, from January to early March.

Taxonomic remarks

Because of its bifacial leaves, broad ciliate bracts; persistent, entire and oblique disk, two carpels, and 4–6 seeds, *P. primaveralepensis* sp. nov. falls within *P.* sect. *Populus*, the most speciose section of the genus (13 species); it belongs to *P.* subsect. *Tomentosae*, a subsection consisting of white poplars with abaxially pubescent leaves (Eckenwalder 1977a, 1977b). *Populus primaveralepensis* sp. nov. is

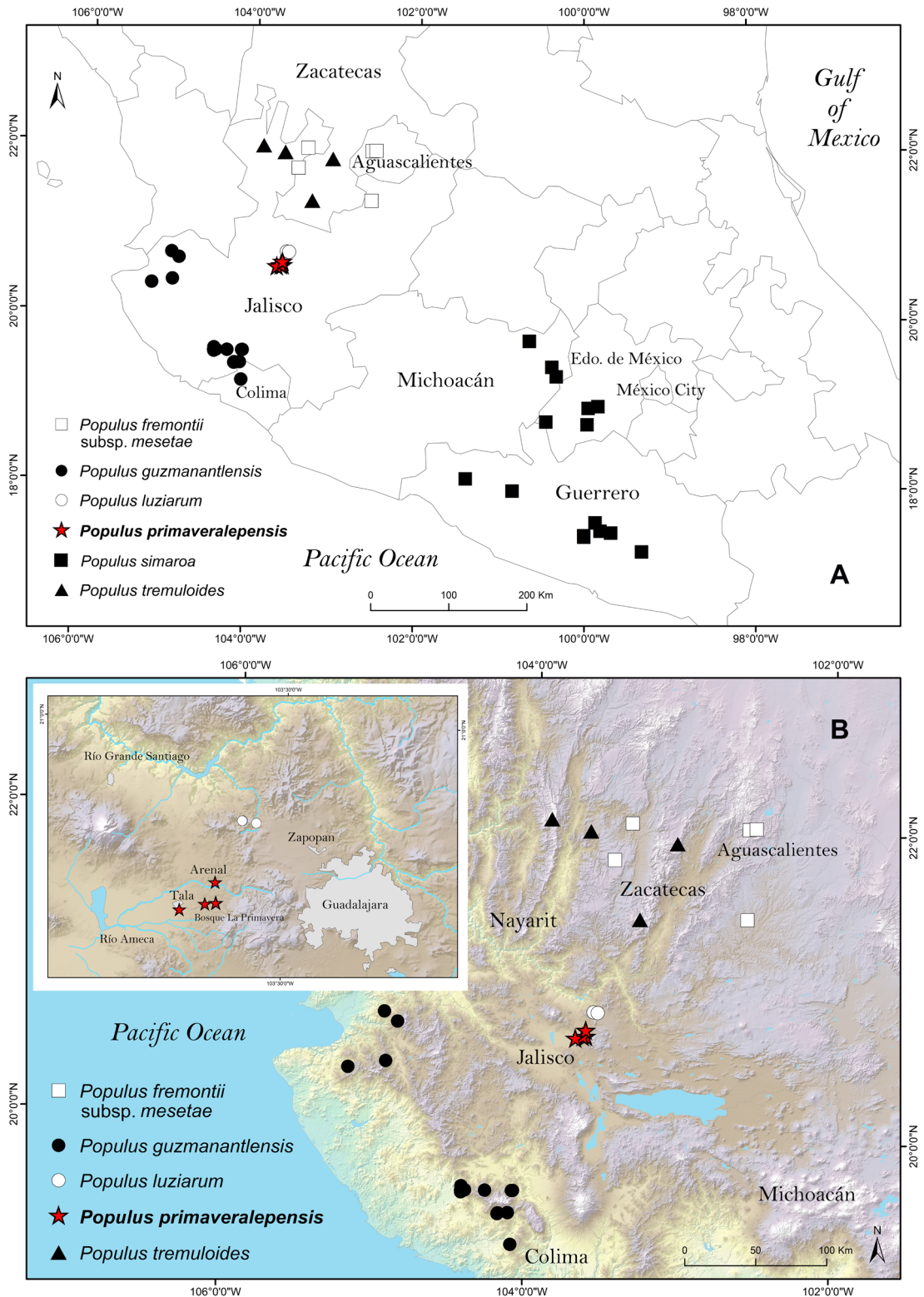


Fig. 5. Maps. **A.** Distribution of *P. primaveralepensis* A.Vázquez, Muñiz-Castro & Zuno sp. nov. and related species of *Populus* L. in western Mexico. **B.** Distribution of the species of *Populus* in Jalisco with a close up for *P. luziarum* A.Vázquez, Muñiz-Castro & Padilla-Lepe and *P. primaveralepensis* sp. nov.

morphologically close to *P. luziarum* in having abaxially tomentose leaves and buds; however, it differs from the latter in having a taller habit (25–30 vs 15–20 m), a different type of spread (exclusively by seeds vs both by seeds and by means of root-borne sucker shoots), branches white and ringed vs brown and not ringed, branching angle (usually ca 45 vs > 75°), longer large-sized leaves with shorter petioles, elliptic to ovate to widely ovate vs widely ovate to ovate-deltoid, rounded to subcordate at the base vs obtuse to rounded to subcordate, and acute at the apex vs rounded, acute to shortly apiculate (Table 1). Additionally, *P. primaveralepensis* sp. nov. differs from *P. luziarum* in terms of its phenology, losing leaves during winter vs autumn.

Ethnobotany

The species is locally known as “álamo”. There is no available information on the use of the species in Jalisco; however, sometimes it is kept as a shade tree for cows. Like other species in the genus *Populus*, *P. primaveralepensis* sp. nov. is a potential source of cellulose fibers, and can be used as an ornamental tree, or for restoration of watersheds in central Jalisco.

Conservation status

Populus primaveralepensis sp. nov. consists of four small and restricted subpopulations: (1) a single tree in a water spring of a tributary of Río Caliente, Arenal, Bosque La Primavera (20°41'48.00" N, 103°37'49.71" W); (2) a second and largest population (ca 100 trees), located at Llano Grande, Tala, along the Lobera River in Bosque La Primavera (20°39'27.5" N, 103°37'42.2" W); (3) eight trees including some old-growth forms in Tala, along the road to the Instituto Tecnológico Superior de Tala (20°38'33.56" N, 103°41'52.18" W), the older trees, ca 1 m in diameter, are ca 80 years old; (4) two additional trees, nearly 2 km east of the “Macrolibramiento” highway of the Guadalajara metropolis, along Río La Lobera (20°39'18.64" N, 103°38'56.54" W, male tree; 20°39'17.28" N, 103°39'7.25" W, female tree).

The known Extent of Occurrence (EOO) of *P. primaveralepensis* sp. nov. is ca 97.88 km², but from this area, only an Area of Occupancy (AOO) of ca 48.29 km² is represented by its habitat (relict gallery cloud forests in humid ravines); the rest is occupied by human settlements (Tala city and La Primavera town), country roads, highways, agriculture, and pasturelands, even inside the BLPBR. Hence, according with IUCN Red List criteria B1ab(iii) (IUCN 2012), *P. primaveralepensis* sp. nov. should be categorized as Critically Endangered, an addition to the flora of conservation concern at BLPBR (Table 2), because it has an EOO < 100 km², very small and restricted subpopulations which are severely fragmented; there are less than 120 individuals known, and there is a continuing observed and projected decline in the area and quality of its habitat (relict gallery cloud forest).

Populus primaveralepensis sp. nov. is extremely rare, thus it should be protected immediately. It is important to disseminate this case and alert the general public that the fragmentation of habitats (mainly road expansion) represents a great threat for these fragile relict ecosystems, which have harboured numerous species for over one hundred millennia (Mahood 1980).

Discussion

Conservation status

Populus primaveralepensis sp. nov. and *P. luziarum* belong to the *P.* subsect. *Tomentosae* and are likely closely related phylogenetically. Based on cpDNA sequences, it has been confirmed that *P.* sect. *Populus* represents a monophyletic group, although the phylogenetic relationships within the section are still uncertain (Wang *et al.* 2015; Zhang *et al.* 2017). This section has a relatively young evolutionary history, and because of fossil records, and morphological and molecular phylogenetic analyses (Eckenwalder 1996; Wang *et al.* 2014, 2015), it is inferred that this group originated from the rapid radiation of

Table 2. Plant species of conservation concern at Bosque La Primavera Biosphere Reserve, Jalisco, Mexico (Hernández-López 2006; Hernández-López *et al.* 2006, 2009a, 2009b; SEMARNAT 2010; IUCN 2012). [S, succulent; H, herb; T, tree; O, terrestrial orchid.]

Species	Biological Form	Endemic to	Conservation Status	Municipality		Elevation (m a.s.l.)
				Arenal	Tala Zapopan	
<i>Agave guadalajarana</i> Trel.	S	Jalisco	–	×	×	1650–1850
<i>Aristida jaliscana</i> R. Guzmán	H	Guanajuato, Jalisco	–	×	×	1500–2100
<i>Calcaratolobelia villaregalis</i> (T.J.Ayers) Wilbur	H	Sierra La Primavera	–	×	×	ca 1500–1700
<i>Cedrela dugesii</i> S. Watson	T	Nueva Galicia	Special Protection (NOM-059-SEMARNAT-2010)	×	×	1700–2100
<i>Coreopsis cyclocarpa</i> S.F.Blake	H	Jalisco	–	×	×	ca 1500–1600
<i>Cosmos landii</i> var. <i>achalconensis</i> Melchert	H	Sierra La Primavera	–	×	×	ca 1500
<i>Cyripedium irapeanum</i> La Llave & Lex.	O	Nueva Galicia	Endangered (NOM-059-SEMARNAT-2010), Vulnerable B2ab(ii,iii,v) (IUCN)	×	×	1750–2150
<i>Echeveria novogaliciana</i> J. Reyes, Brachet & O. González	S	Nueva Galicia	–	×	×	1800–2400
<i>Ilex dugesii</i> Fernald	T	Nueva Galicia	–	×	×	850–2300
<i>Magnolia pugana</i> (Iltis & Vázquez) Vázquez & Carvajal	T	Nueva Galicia	Endangered B1ab(iii)+ 2ab(iii) (IUCN)	×	×	1300–1800
<i>Mammillaria jaliscana</i> Britton & Rose & Boed.	S	Jalisco	Vulnerable A2c (IUCN)	×	×	1200–2500
<i>Populus primaveralepensis</i> A. Vázquez, Muñiz-Castro & Zuno sp. nov.	T	Sierra La Primavera	Critically Endangered	×	×	1300–1650
<i>Sideroxylon capiri</i> (A.DC.) Pittier	T	Neotropical	Endangered (NOM-059-SEMARNAT-2010)	×	×	400–1200
<i>Zinnia violacea</i> Cav.	H	Central Mexico	Endangered (NOM-059-SEMARNAT-2010)	×	×	ca 800–2000

an ancestral member of *P.* sect. *Leucoides* Spach. The relative recent morphological and evolutionary divergence is presented by the similarities exhibited by *P. luziarum* and *P. primaveralepensis* sp. nov., which could have migrated from a Pleistocene refuge in the Sierra Madre Occidental to the geologically recent Sierra La Primavera volcanic complex (western Transmexican Neovolcanic Belt), which was formed by several eruptions that happened between 120 000 and 20 000 years ago (Mahood 1980). Both species are linked to ravines and permanent streams, and have certainly played an important role in the maintenance and continuity of these ecosystems for at least 120 000 years. Even though the geographical ranges of the two species are only 13.5 km apart, they occur in different basins (Río Ameca and Río Santiago, respectively), exhibiting distinct geomorphological features, and atmospheric and climatic conditions (SEMADES 2006).

Floristic relevance

The riparian communities of *P. primaveralepensis* sp. nov. and *P. luziarum* do not share any tree species (100% dissimilar). Hence, according with their current floristic composition (Table 1), it is evident that the two areas represent two distinct biogeographical histories, with no recent exchange between them, which deserve more attention; they will provide a great opportunity to study the incipient evolutionary history of various floristic elements that have presumably migrated to the La Primavera Forest from the older Sierra Madre Occidental.

Mexico, now with eleven species of *Populus*, represents one third of the worldwide richness of this genus (POWO 2018), and is the richest in the continent followed by USA (eight species) and Canada (five species). Jalisco, with a 45% (five species) of the Mexican species of *Populus*, now matches Chihuahua in terms of absolute richness of species of *Populus*, even though the latter area is nearly three times larger in area (247 460 vs 79 080 km²).

Populus primaveralepensis sp. nov. is now the first species categorized as Critically Endangered (CR) within BLPBR, out of the 14 species of conservation concern in this protected area (Table 2), a reserve with more than 1000 species of vascular plants.

Acknowledgments

We thank the University of Guadalajara-CUCBA, PRODEP-SEP, and SNI-CONACyT, Mexico, for their financial support. We acknowledge curators of the herbaria IBUG and ZEA for their collaboration, Héctor Luquín Sánchez for adding an additional location of the species and Esau Vázquez Verdejo for the illustration. We appreciate the contribution of all reviewers and editors of this manuscript, including Dra. Irina Belyaeva. We thank Dr. Servando Carvajal for his guidance with Latin.

References

- Dickmann D.I. & Kuzovkina J. 2014. Poplars and willows of the world, with emphasis on silviculturally important species. In: Isebrands J.G. & Richardson J. (eds.) *Poplars and Willows: Trees for Society and the Environment*: 88–91. CAB International & FAO, Rome. <https://doi.org/10.1079/9781780641089.0008>
- Eckenwalder J.E. 1977a. North American cottonwoods (*Populus*, Salicaceae) of sect.s *Abaso* and *Aigeiros*. *Journal of the Arnold Arboretum* 58: 193–208. <https://doi.org/10.5962/bhl.part.29239>
- Eckenwalder J.E. 1977b. Systematics of *Populus* L. (Salicaceae) in southwestern North America with special reference to sect. *Aigeiros* Duby. PhD thesis, *University of California, Berkeley*.
- Eckenwalder J.E. 1996. Systematics and evolution of *Populus*. In: Stettler R.F., Bradshaw Jr. H.D, Heilman P.E. & Hinckley T.M. (eds) *Biology of Populus and its Implications for Management and Conservation*: 7–32. NRC Research Press, Ottawa.

- Eckenwalder J.E. 2010. *Populus*. In: Flora of North America Editorial Committee (eds) *Flora of North America North of Mexico*: 5–22. Oxford University Press, New York and Oxford.
- Hernández-López L. 2006. Especies de plantas con problemas de conservación en el en Bosque La Primavera, Jalisco, México. In: Santiago Pérez A.L. (ed.) *I Foro de Investigación y Conservación del Bosque La Primavera, Sep. 22–23, 2005*: 48–49. Zapopan, Jalisco.
- Hernández-López L., González-Hernández C.G., Harker M. & Ramírez-Delgadillo R. 2006. Datos preliminares sobre la distribución y el estado de conservación de tres especies en el Bosque La Primavera, Zapopan, Jalisco. In: Carvajal S. (ed.) *Avances en la Investigación Científica en el Centro Universitario de Ciencias Biológicas y Agropecuarias*: 348–351. CUCBA, Zapopan.
- Hernández-López L., Harker M. & Ramírez-Delgadillo R. 2009a. Nuevas localidades de *Lobelia villaregalis* (Campanulaceae: Lobelioideae), especie endémica de Jalisco. In: Carvajal S. & Pimienta-Barrios E. (eds) *2008 Avances en la Investigación en el CUCBA, XIX Semana Nacional de La Investigación Científica*: 213–215. CUCBA, Zapopan.
- Hernández-López L., Ramírez-Delgadillo R. & Harker M. 2009b. Fitogeografía de tres especies de plantas sujetas a protección especial y amenazadas en el Bosque La Primavera, Jalisco. In: Villavicencio-García R., Santiago-Pérez A.L., Gallegos-Rodríguez A., Hernández-Álvarez E., Hernández López L. & Rodríguez-Alcántar O. (eds) *II Foro de Investigación y Conservación del Bosque La Primavera: Memorias. March 5–6, 2009*: 163–172. Zapopan, Jalisco.
- IPNI 2018. International Plant Names Index. Available from: <http://www.ipni.org> [accessed 7 Apr. 2018].
- IUCN 2012. Guidelines for Application of IUCN Red List Criteria at Regional and National Levels: Version 4.0. Gland, Switzerland and Cambridge.
- Mahood G. A. 1980. Geological evolution of a Pleistocene rhyolitic center-Sierra la Primavera, Jalisco, Mexico. *Journal of Volcanology and Geothermal Research* 8: 199–230. [https://doi.org/10.1016/0377-0273\(80\)90105-5](https://doi.org/10.1016/0377-0273(80)90105-5)
- Martínez-González R.E. & González-Villarreal L.M. 2002. *La familia Salicaceae (Populus) en el estado de Jalisco, México*. Instituto de Botánica, Universidad de Guadalajara, Guadalajara.
- Martínez-González R.E. & González-Villarreal L.M. 2005. *Taxonomía y biogeografía del género Populus, (Salicaceae) en México*. Universidad de Guadalajara, Guadalajara.
- Michaux A. 1803. *Flora Boreali-Americana*. Vol. 2. Levrault, Paris and Strasbourg.
- POWO 2018. Plants of the World Online. Available from: <http://www.plantsoftheworldonline.org> [accessed 10 Apr. 2018].
- Radford A.E., Dickison W.C., Massey J.R. & Bell C.R. 1974. *Vascular Plant Systematics*. Harper and Row, New York.
- Rzedowski J. 1975. Tres dicotiledóneas mexicanas nuevas de posible interés ornamental. *Boletín de la Sociedad Botánica de México* 35: 37–43.
- Rzedowski J. 1985. Análisis de la distribución geográfica de las especies mexicanas del género *Populus* (Salicaceae). *Compte rendu Sommaire des Séances de la Société de Biogéographie* 60: 141–150.
- SEMADES 2006. Diagnóstico de los Subsistemas. Subsistema Natural – Medio Físico. Clima. Cuencas atmosféricas para el Estado de Jalisco. Geomática. Informe Final del Proyecto de Ordenamiento Ecológico Territorial del Estado de Jalisco, México. Available from <http://siga.jalisco.gob.mx/moet> [accessed 22 Sep. 2018].

SEMARNAT 2010. Norma Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. *Diario Oficial de la Federación* (30 Dec. 2010) 2: 1–77.

Thiers B. 2017. Index Herbariorum: A Global Directory of Public Herbaria and Associated Staff. New York Botanical Garden's Virtual Herbarium. Available from: <http://sweetgum.nybg.org/science/ih> [accessed 10 Nov. 2017].

Vázquez-García J.A. & Cuevas-Guzmán R. 1989. Una nueva especie tropical de *Populus* (Salicaceae) de la Sierra de Manantlán, Jalisco, México. *Acta Botánica Mexicana* 8: 39–45. <https://doi.org/10.21829/abm8.1989.586>

Vázquez-García J.A., Muñoz-Castro M.A., Padilla-Lepe J., Pulido-Ávila M.G., Nieves-Hernández G. & Martínez-González R.E. 2017. *Populus luzae* [*luziarum*] (Salicaceae), a new species of white poplar endemic to the western Transmexican Volcanic Belt, in Zapopan, Jalisco, Mexico. *Phytotaxa* 328 (3): 243–256. <https://doi.org/10.11646/phytotaxa.328.3.3>

Wang Z., Du S., Dayanandan S., Wang D., Zeng Y. & Zhang J. 2014. Phylogeny reconstruction and hybrid analysis of *Populus* (Salicaceae) based on nucleotide sequences of multiple single-copy nuclear genes and plastid fragments. *PLOS ONE* 9 (8): e103645. <https://doi.org/10.1371/journal.pone.0103645>

Wang D., Wang Z., Du S. & Zhang J. 2015. Phylogeny of sect. *Leuce* (*Populus*, Salicaceae) inferred from 34 chloroplast DNA fragments. *Biochemical Systematics and Ecology* 63: 212–217. <https://doi.org/10.1016/j.bse.2015.09.020>

Zhang L., Shang C., Du F.K., Zhao F., Xiong B. & Zhang Z. 2017. Chloroplast phylogenomic analyses maternal relationships among sections in the genus *Populus*. *Biochemical Systematics and Ecology* 70: 132–140. <https://doi.org/10.1016/j.bse.2016.11.008>

Manuscript received: 28 April 2018

Manuscript accepted: 30 November 2018

Published on: 14 February 2019

Topic editor: Frederik Leliaert, Ph.D.

Desk editor: Alejandro Quintanar

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