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 45º, leaves with higher blade to petiole ratio, leaves 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.
Introduction


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

Material and methods

*Populus primaveralepensis* 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 Tesistán, 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 herbarium 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. primaveralepensis* 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; Martinez-González & González-Villarreal 2002, 2005; Rzedowski 1975, 1985; Vázquez-García & Cuevas-Guzmán 1989; Vázquez-García et al. 2017).

<table>
<thead>
<tr>
<th>Traits</th>
<th><em>P. primaveralepensis</em></th>
<th><em>P. luzae</em></th>
<th><em>P. tremuloides</em></th>
<th><em>P. guzmanantlensis</em></th>
<th><em>P. fremontii</em> subsp. <em>mesetae</em></th>
<th><em>P. simaroa</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Habit</td>
<td>non-soboliferous</td>
<td>soboliferous (usually)</td>
<td>soboliferous (usually)</td>
<td>soboliferous (rarely)</td>
<td>soboliferous (usually)</td>
<td>soboliferous (frequently)</td>
</tr>
<tr>
<td>Tree dbh (m)</td>
<td>0.3–1.2</td>
<td>0.3–1.5</td>
<td>0.1–0.2(0.3)</td>
<td>0.5–1.9</td>
<td>0.2–1.2</td>
<td>(0.3)1.5–2.0</td>
</tr>
<tr>
<td>Bark</td>
<td>rarely furrowed, even the tall trees, upper branches white, usually at an angle ca 45º</td>
<td>evidently furrowed, even the middle aged trees, upper branches brown, usually at an angle &gt;75º</td>
<td>smooth to slightly furrowed</td>
<td>smooth when young to longitudinally sulcate</td>
<td>deeply furrowed</td>
<td>deeply furrowed</td>
</tr>
<tr>
<td>Petiole Length (cm)</td>
<td>2.0–4.2(5.4)</td>
<td>(3.7)4.5–6.0</td>
<td>2.0–8.0</td>
<td>(2.0)4.0–8.0(10.0)</td>
<td>5.0–6.0</td>
<td>2.0–8.0</td>
</tr>
<tr>
<td>Shape</td>
<td>laterally compressed at the blade union densely pubescent</td>
<td>barely laterally compressed glabrous to pubescent</td>
<td>laterally compressed at the blade union glabrous</td>
<td>cylindrical at the blade union pubescent</td>
<td>transversely flattened at blade union pubescent</td>
<td>laterally compressed</td>
</tr>
<tr>
<td>Pubescence</td>
<td>(7.0)9.3–18.5 × (4.5)7–10.2(14.3)</td>
<td>(9.5)10.5–15.0(16.0) × (7.8)8.8–13.4(14.2)</td>
<td>2.5–8.5 × 2.0–8.0</td>
<td>3.0–14.0(16.0) × 5.0–10.0(13.0)</td>
<td>(2.0)4.0–14.0 × 2–8</td>
<td>8.0–23.0 × 5.0–13.0</td>
</tr>
<tr>
<td>Leaf blade size (cm)</td>
<td>elliptic to ovate to widely ovate</td>
<td>widely ovate to suborbicular</td>
<td>ovate to suborbicular, occasionally rhombic or cordate</td>
<td>broadly deltoid-ovate, trullate at young shoots</td>
<td>ovate-deltoid to rhombic-ovate</td>
<td></td>
</tr>
<tr>
<td>Leaf shape</td>
<td>acute</td>
<td>rounded, acute to shortly acutiplicate</td>
<td>abrupt and acutely acuminate</td>
<td>apiculate 3–15 mm, obtuse or rounded</td>
<td>long-acuminate</td>
<td>acute to acuminate</td>
</tr>
<tr>
<td>Leaf apex</td>
<td>rounded to subcordate</td>
<td>obtuse to rounded to subcordate</td>
<td>rounded to subcordate</td>
<td>rounded, cordate, obtuse, rarely oblique</td>
<td>truncate to subcordate, cuneate at young shoots</td>
<td>truncate to subcordate</td>
</tr>
<tr>
<td>Leaf base</td>
<td>puberulent, tertiary veins not very prominent</td>
<td>glabrous, glaucous, tertiary veins not prominent</td>
<td>pubescent, tertiary veins very prominent</td>
<td>glabrous, tertiary veins not prominent</td>
<td>densely pubescent, tertiary veins very prominent</td>
<td></td>
</tr>
<tr>
<td>Abaxial leaf surface</td>
<td>Length of mature male inflorescence (mm)</td>
<td>10–70</td>
<td>45–65</td>
<td>38–60(90)</td>
<td>10–30</td>
<td>40–130</td>
</tr>
<tr>
<td>Number of stamens</td>
<td>6–12</td>
<td>9–13</td>
<td>6–18</td>
<td>7–15</td>
<td>30–70</td>
<td>10–18</td>
</tr>
<tr>
<td>Traits</td>
<td>( P. ) primaveralepensis</td>
<td>( P. ) luzae</td>
<td>( P. ) tremuloides</td>
<td>( P. ) guzmanantensis</td>
<td>( P. ) fremontii subsp. mesetae</td>
<td>( P. ) simaroa</td>
</tr>
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</tr>
<tr>
<td>Male bracteoles</td>
<td>ovate, margin entire and ciliate, dentate at the apex, unlobed, 2.5–3.7 × 1.7 mm</td>
<td>ovate, scarcely pubescent, margin entire, ciliated, unlobed, 0.7–1.0 mm long</td>
<td>margin with 3–5 lanceolate lobes, ciliated, 2.0 mm long</td>
<td>spatulate, deciduous pubescence, margin dentate to parted, ciliated, 2.0–3.0 mm long</td>
<td>narrowly ovate, margin entire, unlobed, 2.5–3.0 mm long</td>
<td>very variable in shape, margin entire, lacinate to lobed, irregularly ciliated, 1.5–2.0 mm long</td>
</tr>
<tr>
<td>Female bracteoles</td>
<td>2.0–3.0 mm long, sparsely denticulate to entire, none lobed, ciliated</td>
<td>2.6–3.2 mm long, with denticles, unlobed, ciliated</td>
<td>3.0–5.0 mm long lobed, non-ciliated</td>
<td>1.2–1.5 mm long evidently lobed, ciliated</td>
<td>6.0–8.0 mm long, narrow.</td>
<td>1.5–2.0 mm long, lobed, ciliated</td>
</tr>
<tr>
<td>Mature female inflorescence (mm)</td>
<td>40–80</td>
<td>50–60(80)</td>
<td>40–60</td>
<td>50</td>
<td>40–140</td>
<td>45</td>
</tr>
<tr>
<td>Dehiscing carpels</td>
<td>Number of carpels</td>
<td>30–80</td>
<td>dense</td>
<td>(35)75–70(77)</td>
<td>sparse</td>
<td>70–130</td>
</tr>
<tr>
<td>Arrangement</td>
<td>Capsule length (mm) and pubescence</td>
<td>1.0–1.8 × 0.6–0.9, pubescent</td>
<td>2.0–2.5, pubescent</td>
<td>(3.0)6.9–0.0, glabrous</td>
<td>2.0–3.0, glabrous</td>
<td>6.0–10.0, glabrous</td>
</tr>
<tr>
<td>Deciduousness of foliage</td>
<td>Winter (Jan.–early Mar.)</td>
<td>at the beginning of autumn</td>
<td>Winter</td>
<td>Middle summer to autumn (Aug.–Nov.)</td>
<td>Winter</td>
<td>Summer</td>
</tr>
<tr>
<td>Habitat</td>
<td>gallery cloud forest</td>
<td>gallery mixed forest with tropical moist and cloud forest elements</td>
<td>( Pinus ) arizonica forest</td>
<td>tropical subdeciduous forest-cloud forest ecotone</td>
<td>oak forests</td>
<td>cloud forest, pine-oak forests</td>
</tr>
<tr>
<td>Elevation (m a.s.l.)</td>
<td>1330–1640</td>
<td>1330–1460</td>
<td>2650</td>
<td>400–1250</td>
<td>1750–2300</td>
<td>1500–2500</td>
</tr>
<tr>
<td>Mean annual rainfall (mm)</td>
<td>800–1000</td>
<td>900</td>
<td>ca 500</td>
<td>1450–1850</td>
<td>ca 760</td>
<td>ca 670</td>
</tr>
<tr>
<td>Geography</td>
<td>Sierra La Primavera, Ameica river basin, Arenal and Tala, Central Jalisco, western Transmexican Volcanic Belt</td>
<td>Nextipac plateau, Santiago river basin, Zapopan, central Jalisco, western Transmexican Volcanic Belt</td>
<td>Alaska, Canadá, EU, N of Mexico, Mexican Plateau including Northern Jalisco</td>
<td>S to SW Jalisco and Colima, Sierra Madre del Sur mountain range (Vázquez-García &amp; Cuevas-Guzmán 1989)</td>
<td>S of New Mexico, Texas and Mexican Plateau, including N of Jalisco (Eckenwalder 1977a, 1977b)</td>
<td>State of Mexico, Guerrero and Michoacán (Rzedowski 1975, 1985)</td>
</tr>
</tbody>
</table>
Class Magnoliopsida Brongn.
Order Malpighiales Juss. ex Bercht. & J.Presl
Family Salicaceae Mirb.
Genus *Populus* L.
Section *Populus*
Subsection *Tomentosae* Hart.

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

Differential diagnosis

*Populus primaveralepensis* 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. Ibarrarán-Madrigal, and J.J. Padilla-García 252a leg.; IBUG • ♀ fl, fr; same collection data as for preceding; J. Padilla-Lepe, O. Ibarrarán-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 • ♂ fl; Municipio de Tala, Arroyo La Lobera 3.5 km E del Macrolibramiento; 20°39’18.64” N,
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. Ibarrarán.
Fig. 3. *Populus primaveralepensis* 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 primaveralepensis* 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 infrutescence. D. Trunk. E. Branch with leaves and dehiscing capsules, showing the whitish pappus of seeds. Photographs: A. Vázquez.
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. Stamine 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 tecae 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 spathulate, with margin sparsely denticulate to entire, non-lobed, ciliate, caducous, greenish yellow at anthesis, brown-red 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, ciatiform, 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 spathulate, with margin sparsely denticulate to entire, non-lobed, ciliate, caducous, brown-red 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 Rio La Lobera and Rio 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 *Populus 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, it is sometimes 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 Rio 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 Rio 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>
<thead>
<tr>
<th>Species</th>
<th>Biological Form</th>
<th>Endemic to</th>
<th>Conservation Status</th>
<th>Municipality</th>
<th>Elevation (m a.s.l.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agave guadalajarana Trel.</td>
<td>S</td>
<td>Jalisco</td>
<td>–</td>
<td>Arenal</td>
<td>1650–1850</td>
</tr>
<tr>
<td>Aristida jaliscana R.Guzmán</td>
<td>H</td>
<td>Guanajuato, Jalisco</td>
<td>–</td>
<td>×</td>
<td>1500–2100</td>
</tr>
<tr>
<td>Calcaratolobelia villaregalis (T.J.Ayers) Wilbur</td>
<td>H</td>
<td>Sierra La Primavera</td>
<td>–</td>
<td>×</td>
<td>ca 1500–1700</td>
</tr>
<tr>
<td>Cedrela dugesii S.Watson</td>
<td>T</td>
<td>Nueva Galicia</td>
<td>Special Protection (NOM-059-SEMARNAT-2010)</td>
<td>×</td>
<td>1700–2100</td>
</tr>
<tr>
<td>Coreopsis cyclocarpa S.F.Blake</td>
<td>H</td>
<td>Jalisco</td>
<td>–</td>
<td>×</td>
<td>ca 1500–1600</td>
</tr>
<tr>
<td>Cosmos landii var. achalconensis Melchert</td>
<td>H</td>
<td>Sierra La Primavera</td>
<td>–</td>
<td>×</td>
<td>ca 1500</td>
</tr>
<tr>
<td>Echeveria novogaliciana J. Reyes, Brachet &amp; O. González</td>
<td>S</td>
<td>Nueva Galicia</td>
<td>–</td>
<td>×</td>
<td>1800–2400</td>
</tr>
<tr>
<td>Ilex dugesii Femald</td>
<td>T</td>
<td>Nueva Galicia</td>
<td>–</td>
<td>×</td>
<td>850–2300</td>
</tr>
<tr>
<td>Magnolia pugana (Iltis &amp; Vázquez) Vázquez &amp; Carvajal</td>
<td>T</td>
<td>Nueva Galicia</td>
<td>Endangered B1ab(iii)+ 2ab(iii) (IUCN)</td>
<td>×</td>
<td>1300–1800</td>
</tr>
<tr>
<td>Mammillaria jaliscana Britton &amp; Rose &amp; Boed.</td>
<td>S</td>
<td>Jalisco</td>
<td>Vulnerable A2c (IUCN)</td>
<td>×</td>
<td>1200–2500</td>
</tr>
<tr>
<td>Populus primaveralepensis A.Vázquez, Muñiz-Castro &amp; Zuno sp. nov.</td>
<td>T</td>
<td>Sierra La Primavera</td>
<td>Critically Endangered</td>
<td>×</td>
<td>×</td>
</tr>
</tbody>
</table>
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.

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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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