



Pinus vallartensis (Pinaceae), a new species from western Jalisco, Mexico

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Abstract

We propose and describe *Pinus vallartensis* Pérez de la Rosa & Gernandt as a new species from western Jalisco, Mexico. The pine occurs near the southern limit of the Sierra Occidental at the intersection of the municipalities of Puerto Vallarta, Cabo Corrientes, and Talpa de Allende. *Pinus oocarpa* occurs within the margins of this forest to the south and *P. jaliscana* to the west. The more distantly related pine, *P. maximinoi*, also grows in the area. *Pinus vallartensis* is like *P. jaliscana* and *P. oocarpa* in possessing leaf resin canals in a septal condition and serotinous seed cones on slender peduncles. It is distinguished mainly by its small seed cones and lax foliage. This discovery highlights the exceptional diversity of pines in Mexico and the state of Jalisco.

Resumen

Se propone y describe *Pinus vallartensis* Pérez de la Rosa & Gernandt como una especie nueva del oeste de Jalisco, México. El pino se distribuye cerca del límite sur de la Sierra Occidental en la intersección de los municipios de Puerto Vallarta, Cabo Corrientes y Talpa de Allende. En los márgenes de este bosque se han encontrado al sur *P. oocarpa* y al oeste *P. jaliscana*. Un pino más distantemente relacionado, *P. maximinoi*, también se localiza en la zona. *Pinus vallartensis* se asemeja a *P. oocarpa* y *P. jaliscana* por compartir la característica de poseer canales resiníferos septales en las hojas y conos seróticos sostenidos por pedúnculos delgados. Se distingue principalmente por el reducido tamaño de los conos ovulados y el follaje flácido. Este descubrimiento destaca la excepcional diversidad de pinos en México y el estado de Jalisco.

Key words: pine, Oocarpa Group, septal, ovoid cones

Introduction

Pinus Linnaeus (1753: 1000), with approximately 120 species, is the most diverse genus of the family Pinaceae (Farjon & Filer 2013). Mexico is considered a secondary center of origin and diversification of pines. It has more native species than any other country with 49, including 22 endemics occurring naturally within its territory (Gernandt and Pérez-de la Rosa 2014). The Sierra Madre Occidental and Sierra Madre del Sur are particularly rich. For example, 21 species of pine are reported for Durango, 14 for Guerrero, and 16 for Oaxaca (del Castillo *et al.* 2004; Fonseca 2013; García-Arévalo & González-Elizondo 2003). With the present discovery, the number of species reported for the state of Jalisco is increased to 20 (Farjon & Styles 1997; Pérez de la Rosa 1998; Pérez de la Rosa 2009), and the number of species for Mexico rises to 50 (Gernandt and Pérez-de la Rosa 2014).

Material & Methods

Near the end of 2013, Dr. Miguel Muñiz invited the first author to a field site south of the coastal city of Puerto Vallarta, Jalisco in the Sierra de El Cuale. This mountain chain forms the northern limit of the Sierra Madre del Sur (Rzedowski 1978, Espinosa *et al.* 2016). It is known locally as the Sierra Occidental because it is situated in western Jalisco.

The objective of the expedition was to search for additional localities of the recently described species, *Magnolia vallartensis* Vázquez & Muñiz-Castro (2012: 124), which occurs at relatively low elevations for the genus. After ascending steep and winding paths for a little more than an hour, there is an area of semi-tropical climate at an elevation of approximately 400 m known locally as “Las Juntas”, which refers to the confluence of the streams “Palo María” and “Chupalodo”. Young individuals of *Magnolia* are common growing along the stream margins. It was at this site 13 kilometers in a straight line south of the Puerto Vallarta city center that this pine taxon was first discovered. Individual trees grow scattered on a northerly exposed hillside with grassland and open forest of pine and oak that resembles the savanna pine forests of Central America.

Additional fieldwork was conducted through September 2016 to establish the range of the taxon and its phenology. All collections were made from the only population known to date. Specimens of cones and seeds were digitally photographed and the resulting image files were edited in Adobe Photoshop and Illustrator version CS5.1. Specimens are housed in the herbarium of the Instituto de Botánica, Universidad de Guadalajara (IBUG) and in the Herbario Nacional, Instituto de Biología, Universidad Nacional Autónoma de México (MEXU). Additional isotypes will be distributed to ARIZ, K, MO, NY, and US (acronyms follow Thiers 2017, continuously updated).

Taxonomy

Pinus vallartensis Pérez de la Rosa & Gernandt, *sp. nov.* (Fig. 1)

Type:—MEXICO. Jalisco: municipio de Puerto Vallarta, 100 m al sur de “Las Juntas” (arroyos Palo María y Chupalodo), 20°31'53.5"N, 105°14'41.8"W, elevation 423 m, 17 September 2016, *J.A. Pérez de la Rosa & D. Gernandt 2134* (holotype: IBUG!; isotype MEXU!).

Diagnosis:—Similar to *Pinus oocarpa* and *P. jaliscana*, differing in its lax leaves and smaller seed cones that range in length from (2.2–)2.5–3(–4.0) cm.

Trees (6–)8–12(–18) m, trunk 30–50 cm in diameter, generally tortuous; bark 2–4 cm thick, occasionally thicker, light gray outside and reddish-brown inside, in rectangular plates, crown ample and open, making up 1/2 to 1/4 of the total height, light green. Fascicles persisting 2–3 years, rarely more; cataphylls brown to yellowish brown, 3.6–4.2 mm × 2–2.5 mm at the base, margins hyaline and ciliate, sheaths (1.0–)1.2–1.5 cm, yellowish brown when young, dark grey to almost black upon maturity, with 8–10 bracts. Leaves in fascicles of (3–4–)5, lax, light green, finely serrate, (12–)17–20(–22) cm × 0.8–0.9 mm with 3–4(–5) rows of stomata on the abaxial face and 2–3 on each of the adaxial faces. Pollen cones 11–27 mm × 4–6 mm, brown to yellowish brown, with the superior margin of the scales finely dentate. Seed cones ovoid, solitary or in pairs, rarely in whorls of three, (2.2–)2.5–3(–4.0) cm × (2.6–)3.1–3.5(–4.0) cm when open, on peduncles 0.8–1.8 cm × 3–5.5 mm, persistent, falling with the cone; seed scales 34–53 per cone, yellowish brown, lustrous. Seeds dark brown to yellowish brown, 5.3–7.3 mm × 3.4–4 mm, with wings 12–15 × 3–5 mm. Number of cotyledons: 4–7.

Leaf anatomy:—Epidermis thin and uniform, hypodermis irregular with interstomatal intrusions into the mesophyll reaching the endodermis; resin canals septal, 3–6 contained within the septal hypodermis, 1–3 on the abaxial face and 1–2 on each adaxial face; endodermis with ovoid cells and uniform walls, two proximal vascular bundles.

Distribution:—To date, no hard pine (subgenus *Pinus*) with a more restricted population has been found in the state of Jalisco. The species is almost exclusive to the southern part of the municipality of Puerto Vallarta (Fig. 2). The populations are reached by ascending paths, and have a north-south and east-west exposure. At its southern limit the species enters the municipalities of Cabo Corrientes and Talpa de Allende, from 20°32'36.5"N; 105°14'14.9"W at its northern limit to 20°28'06.9"N; 105°13'22.4"W at its southern limit; at elevations of 380–1347 m a.s.l.

Ecology:—According to the terrestrial biogeographic classification of Cuanalo de la Cerda *et al.* (1989), *P. vallartensis* occurs in the Sierra Madre del Sur terrestrial province, between the subregions Planicie Higuera Blanca (Eb6) and Sierra Talpa de Allende (Eg3), where the predominant soils are Pellic Vertisols, Vitric Andosols, Chromic Luvisols, and Eutric Nitosols; these are acidic and deep, on north facing exposures. The median temperature is 26 °C and the annual precipitation is 1200 mm (Villalpando & García 1993). The species is associated with *Muhlenbergia distichophylla* (J. Presl.) Kunth (1833: 202), which is favored by the high frequency of fires in the region. Deneven (1961) described a similar association for *P. oocarpa* in Nicaragua denominated sub-climax vegetation, similar to the pine savannahs of Central America. It is also associated with other tree species such as *Byrsonima crassifolia* (L.)

Kunth (1822: 149), *Quercus aristata* Hooker & Arnott Walker-Arnott (1841: 444), *Q. elliptica* Née (1801: 278), *Q. magnoliifolia* Née (1801: 268), and *Bejaria mexicana* Benth (1839: 15). At more humid sites such as along stream banks it occurs with *Magnolia vallartensis* and *Clusia salvinii* Donnell Smith (1903: 1). Its distribution meets *P. oocarpa* at its southern limit and *P. maximinoi* Moore (1966: 8) and *P. jaliscana* near its western limit.

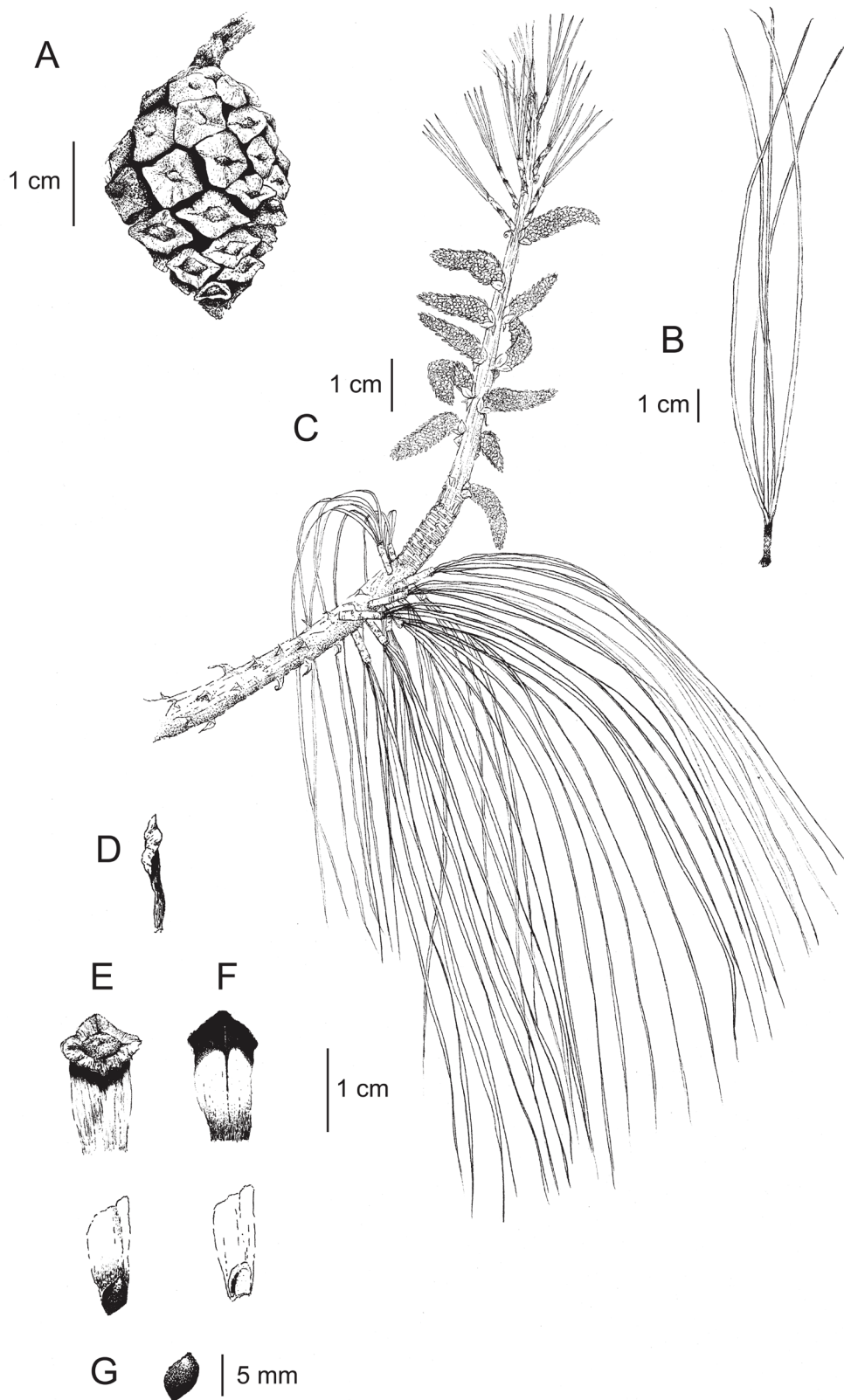


FIGURE 1. *Pinus vallartensis* sp. nov., A, seed cone, B, leaves, C, branch with leaves and pollen cones D, lateral view of cone scale, E, abaxial view of cone scale, F, adaxial view of cone scale, G, seeds with articulate wings. (Illustration by Gretchen Rodríguez, from *J. A. Pérez de la Rosa & D. Gernandt 2134 in MEXU*).

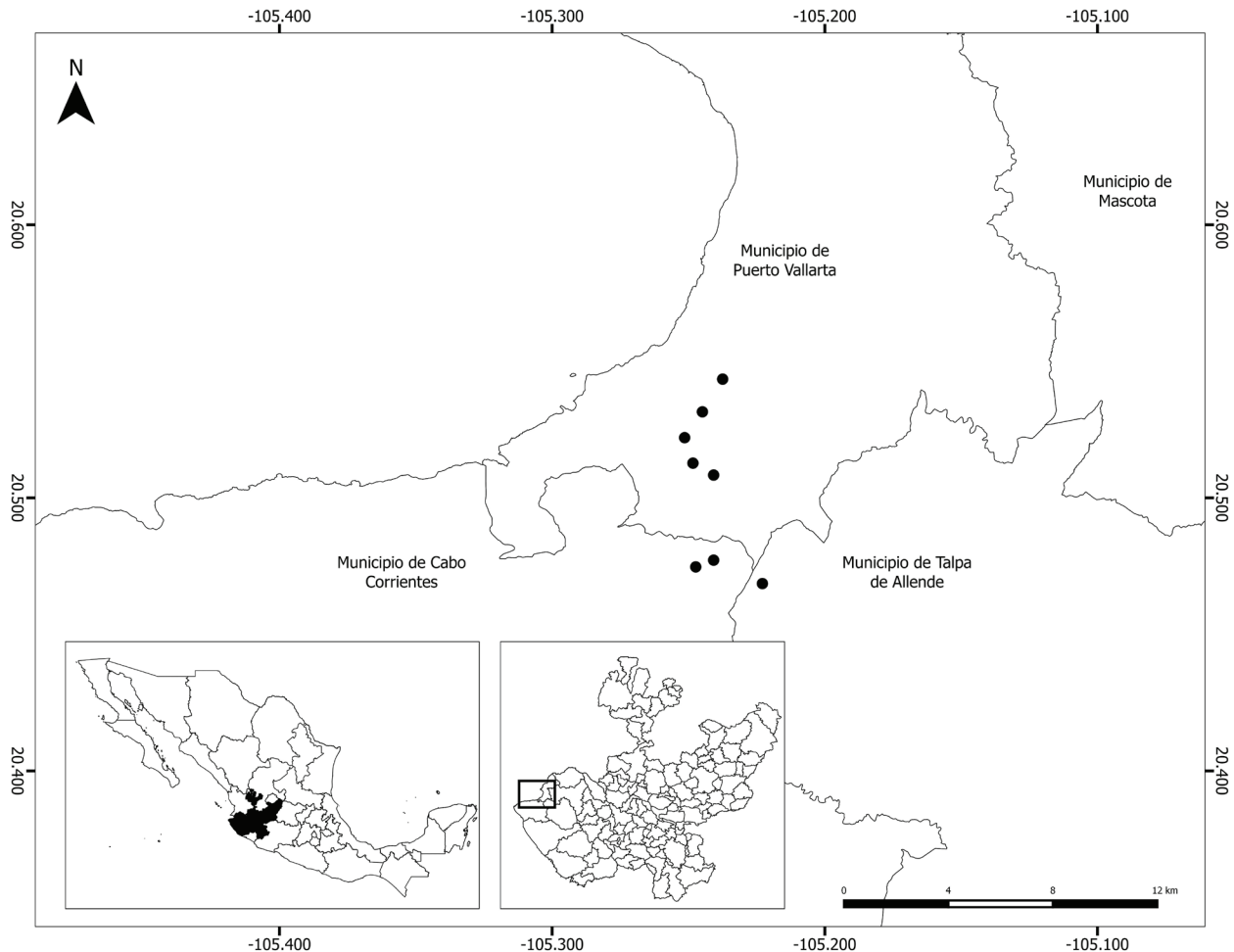


FIGURE 2. Distribution map for *Pinus vallartensis* in western Mexico.

Additional material examined (paratypes):—MEXICO. Jalisco: municipio de Puerto Vallarta, al sur del puerto, en las lomas que están entre los arroyos “Palo María” y “Chupa Lodo”, 20°31′53.4″N, 105°14′41.6″W, elev. 380 m, 30 November 2013, *Pérez de la Rosa 2092* (IBUG!). Municipio de Puerto Vallarta, al sur del Puerto, al este de Mismaloya, 20°30′45.7″N, 105°14′54.1″W, elev. 703 m, 14 January 2014, *Pérez de la Rosa 2094* (IBUG!, MEXU!). Municipio de Puerto Vallarta, al sur del Puerto, al E de Mismaloya, Los Miradores, 20°31′19.3″N, 105°15′05.1″W, elev. 704 m, 14 January 2014, *Pérez de la Rosa 2095* (IBUG!, MEXU!). Municipio de Puerto Vallarta, al E de Mismaloya, al oeste de la parte alta de las cascadas, en el helipuerto y sus alrededores, 20°30′30.0″N, 105°14′26.8″W, elev. 446 m, 21 February 2014, *Pérez de la Rosa 2105* (IBUG!, MEXU!). Municipio de Cabo Corrientes, 3.7 km al E de Las Juntas y Los Veranos, Rancho El Coapinal, Cerro El Viguía, 20°28′28.9″N, 105°14′50.4″W, elev. 996 m, 9 March 2014, *Pérez de la Rosa 2109* (IBUG!, MEXU!). Municipio de Cabo Corrientes, Cerro “La Ocotosa”, al E de Las Juntas” y “Los Veranos”, 20°28′37.8″N, 105°14′26.8″W, elev. 1000 m, 9 marzo 2014, *Pérez de la Rosa 2113* (IBUG!, MEXU!). Municipio de Talpa de Allende, “Las Palomas”, entre los ranchos “El Guapinole” y “Cerro Azul”, 20°28′06.9″N; 105°13′22.4″W, elev. 1347 m, 24 August 2014, *Pérez de la Rosa 2117* (IBUG!, MEXU!). Municipio de Puerto Vallarta, al sur del puerto, aproximadamente 1 km al norte de “Las Juntas” (arroyos “Palo María” y “Chupalodo”), 20°32′36.5″N, 105°14′14.9″W, elev. 438 m, 11 January 2016, *Pérez de la Rosa 2121* (IBUG!, MEXU!).

Local name:—”Pino”.

Phenology:—The period of pollination occurs in the months of August and September. Seeds are dispersed in March and April and germination takes place between May and June, 7–12 days after the first rain.

Etymology:—The name of this pine is in honor of the municipality of Puerto Vallarta, where the main part of the population of this species is found. It seems to be the only pine that occurs in this municipality.

Discussion:—Pérez de la Rosa (2001) reviewed herbaria throughout Mexico and found no previously collected specimens similar to *P. vallartensis*. The absence of the species in collections may be due to the inaccessibility of the locality. The globose shape of the ovulate cones, needle anatomy with septal resin canals, and the branchy early phases

of development suggest that *P. vallartensis* and *P. oocarpa* are closely related. They belong to Martínez's (1948) "Grupo Oocarpa", which he classified (without providing a Latin diagnosis) in "Sección Serótinios", a taxonomically heterogeneous assortment of hard pine species with serotinous seed cones. As circumscribed by Martínez (1948), the Oocarpa group included five hard pine taxa with symmetric, ovoid, or shortly compressed-ovoid ovulate cones, with luteate, ochre, or reddish seed scales, and a weak, elongated, and thin peduncle. *Pinus* subsection *Oocarpae* Little & Critchfield (1969: 15) was erected for seven species colloquially described as the egg-cone pines. Farjon & Styles (1997) and Price *et al.* (1998) transferred additional species to *Pinus* subsection *Oocarpae*, although their circumscriptions differed markedly. Price *et al.* (1998) further divided the subsection into the informal "Oocarpa group", with seven species and two varieties, and the "Teocote group", with two species and one additional variety. With the addition of *P. vallartensis*, we recognize 16 species and two additional varieties for the Oocarpa group (Table 1). Ten of these species occur naturally in Jalisco.

TABLE 1. Taxa classified in the Oocarpa group and their geographic distribution.

Taxon	Distribution
<i>Pinus chihuahuana</i> Engelm. (1848: 103).	Mexico and southwestern United States
<i>Pinus georginae</i> Pérez de la Rosa (2009: 56)	Western Mexico
<i>Pinus greggii</i> Engelm. ex Parlatore (1868: 396)	Northeastern Mexico
<i>Pinus greggii</i> var. <i>australis</i> Donahue & Lopez Upton (1999: 1092)	Eastern Mexico
<i>Pinus herrerae</i> Martínez (1940: 76)	Western Mexico
<i>Pinus jaliscana</i> Pérez de la Rosa (1983: 290)	Western Mexico
<i>Pinus lawsonii</i> Roezl ex Gordon (1862: 64)	Mexico
<i>Pinus leiophylla</i> Schiede ex Schlechtendal & Chamisso (1831: 354)	Mexico
<i>Pinus lumholtzii</i> Robinson & Fernald (1894: 122)	Western Mexico
<i>Pinus luzmariae</i> Pérez de la Rosa (1998: 127)	Western Mexico
<i>Pinus oocarpa</i> Schiede ex Schlechtendal (1838: 491)	Mexico and Central America
<i>Pinus patula</i> Schiede ex Schlechtendal & Chamisso (1831: 354)	Eastern and southern Mexico
<i>Pinus patula</i> var. <i>longipedunculata</i> Looock ex Martínez (1948: 333)	Southern Mexico
<i>Pinus praetermissa</i> Styles & McVaugh (1990: 310)	Western Mexico
<i>Pinus pringlei</i> Shaw (1905: 211)	Mexico
<i>Pinus tecunumanii</i> Eguiluz & J.P. Perry (1983: 4)	Southern Mexico and Central America
<i>Pinus teocote</i> Schiede ex Schlechtendal & Chamisso (1830: 76).	Mexico
<i>Pinus vallartensis</i> Pérez de la Rosa & Gernandt	Western Mexico

Plastid DNA studies did not recover *Pinus* subsection *Oocarpae* or other more narrowly circumscribed subsections or groups as mutually monophyletic, leading Gernandt *et al.* (2005) to merge *Pinus* subsection *Attenuatae* Van der Burgh (1973: 93; the California closed coned pines), *Pinus* subsection *Leiophyllae* Loudon (1844: 2273), and *Pinus* subsection *Oocarpae* into a more broadly defined *Pinus* subsection *Australes* Loudon (1844: 2255; the southern yellow pines). *Pinus* subsection *Australes* in turn was included in the "North American hard pines" of *Pinus* section *Trifoliae* Duhamel (1755: 126) together with subsections *Contortae* Little & Critchfield (1969: 15) and *Ponderosae* Loudon (1844: 2243). The concept of *Pinus* subsection *Australes* in this broader sense not only includes the species from the eastern United States and Antilles (subsection *Australes* s.s.), but also those of western North America (the *Attenuatae*) and the southwestern United States through Mexico and Central America (the *Oocarpae* and *Leiophyllae*).

Pinus subsection *Australes* is the largest subsection in the genus, comprising some 30 species. Further plastid DNA studies have verified the paraphyly of *Pinus* subsects. *Attenuatae* and *Australes* (Parks *et al.* 2012; Hernández León *et al.* 2013), but nuclear DNA studies are also under way to corroborate the plastid results and to more conclusively establish whether the Oocarpa group is monophyletic. At present, the Oocarpa group, or the Oocarpae, is an appealing descriptive name for the serotinous egg-cone pines (including the *Leiophyllae*) naturally distributed in the southwestern United States, Mexico, and Central America.

Despite the similarity between *P. vallartensis* and *P. oocarpa*, the newly-described species can be recognized without difficulty by its diminutive ovulate cones and cataphylls. Sixteen cones taken randomly from several trees had an average length of 2.84 cm and a width of 3.15 cm. They can also be distinguished by the diameter of the shoots (they are thinner) and their flaccid foliage. A third species in the *Oocarpa* group, *P. jaliscana*, borders *P. vallartensis* to the west and shares the disposition of its septal resin canals, but is easily distinguished by its oblongly-conical cone shape, thicker needles, and different pollination periods (Table 2). Another similar species, *P. praetermissa* Styles & McVaugh (1990: 310), has a distribution confined to Jalisco, Nayarit, and Sinaloa. It is distinguished readily from *P. vallartensis* by its leaf resin canals in an internal or medial position; its cone peduncles from 1.5–4.0 cm long compared to no greater than 1.8 cm in *P. vallartensis*; and its larger cones, measuring (4–)5–6.5(–7) cm × (5–)6–8 cm, that upon maturation usually lose a few basal scales (Farjon & Styles 1997; Pérez de la Rosa 2009).

TABLE 2. Comparison of the three species of pines with septal resin canals present in the state of Jalisco. Diagnostic values given for *P. vallartensis* are smaller to intermediate compared with *P. jaliscana* and *P. oocarpa*. The three species are also distinct in their phenology.

Character	<i>P. jaliscana</i>	<i>P. vallartensis</i>	<i>P. oocarpa</i>
Length of leaf fascicle sheaths	8–12.5 mm	(10–)12–15 mm	(13.5–)15–24 mm
Length of leaves	14–18 cm	(12–)17–20(–22) cm	(17.5–)19–30 cm
Diameter of leaves	0.6–0.7 mm	0.8–0.9 mm	1.0–1.7 mm
Length of pollen cones	1.5–2.1 cm	1.1–2.7 cm	2.0–3.4 cm
Diameter of pollen cones	0.3–0.5 cm	0.4–0.6 cm	0.6–0.8 cm
Number of pollen cone basal bracts	11–14	8–10	13–21
Length of seed cones	5.5–7.3 cm	(2.2–)2.5–3(4.0) cm	4–7(–9) cm
Diameter of seed cones	4–5 cm	(2.6–)3.1–3.5(–4.0) cm	4.5–9(–11) cm
Number of seed cone scales	90–115	40–60	110–130
Length of seed wing	15–20 mm	13–16 mm	16–28 mm
Period of pollination	Sept.–Nov.	Aug.–Sept.	Dec.–Feb.

Farjon & Styles (1997) mention that although variable, the number and principally the position of the leaf resin canals can be used as diagnostic characters in *Pinus*. Most Mexican species have a “primary” position and occasionally one or very few canals in another position, referred to as “subsidiary”. Depending on their position they have been described as external, medial, internal, or septal. The only species in Mexico with septal resin canals are *P. oocarpa*, with a wide distribution in the country (according to Styles [1993] it is the most widely distributed tropical species in the world); *P. jaliscana*, endemic to the state of Jalisco; and now, *P. vallartensis*, also endemic to Jalisco, with a limited distribution in the Sierra Madre del Sur. The characters that distinguish these three taxa are summarized in Table 1. The cones and seeds of the three species with septal resin canals are compared in Fig. 3.

Conservation status:—The area of distribution extends across only a few square kilometers, mainly in the southern part of the municipality of Puerto Vallarta, but also in a small portion of the municipalities of Cabo Corrientes and Talpa de Allende. The habitat generally is open grassland, which makes it difficult to find dense forests due to the frequent incidence of fires, both natural and provoked by humans to promote the presence of grasslands for cattle grazing. At present we estimate that the number of mature individuals is fewer than 2,500, although more field exploration is needed. Its restricted distribution, occurring in a rugged terrain with difficult access, is comparable to that of two pinyon pines endemic to Mexico, *Pinus culminicola* Andresen & Beaman (1961: 437) and *P. maximartinezii* Rzedowski (1964: 17). These two species are listed as Endangered by the International Union for the Conservation of Nature (IUCN 2016) and in the *Norma Oficial Mexicana NOM-059* (SEMARNAT 2010). Similarly, because of its low population densities, highly restricted geographic range (as far as its known), and proximity to human activities that may decrease its population size, we estimate that it fulfills IUCN ver. 3.1 (2016) criteria EN B1ab(ii,iii,iv,v)+2ab(ii,i,ii,iv,v) and thus recommend that *P. vallartensis* be treated as an endangered species.

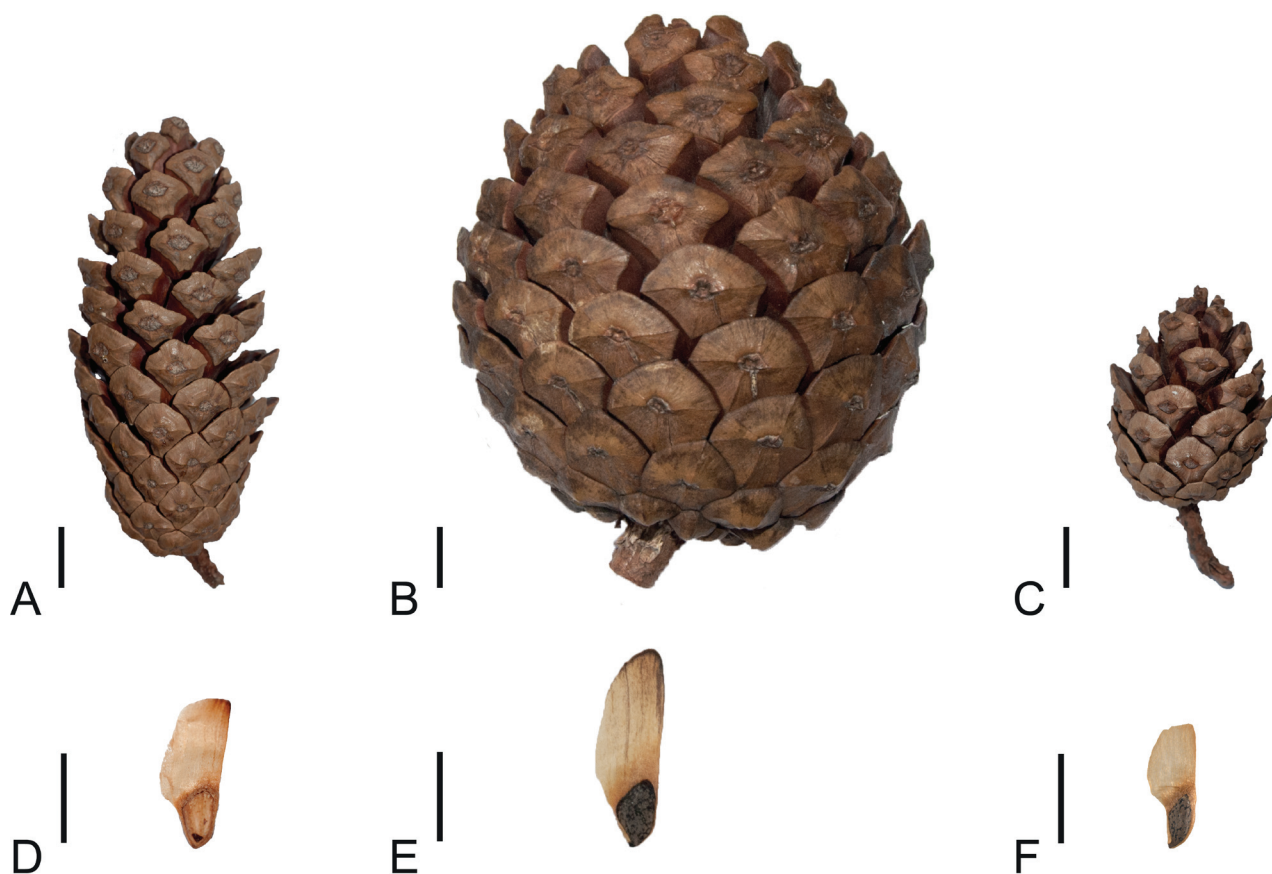


FIGURE 3. Photographs of three pines from the *Oocarpa* group with septal resin canals, A, *Pinus jaliscana* seed cone (J.A. Pérez de la Rosa 1841), B, *Pinus oocarpa* seed cone (D.S. Gernandt 560), C, *Pinus vallartensis* seed cone (J.A. Pérez de la Rosa s.n.), D, *Pinus jaliscana* seed (J.A. Pérez de la Rosa 1841), E, *Pinus oocarpa* seed (D.S. Gernandt 560), F, *Pinus vallartensis* seed (J.A. Pérez de la Rosa s.n.). Bar = 1 cm. (Photos by D.S. Gernandt).

Key to the species of *Pinus* subsection *Australes* in Jalisco

1. Fascicle sheaths early or late deciduous, falling before the leaves2
- Fascicle sheaths persistent, falling with the leaves5
2. Leaves > 1 mm wide, in fascicles of 33
- Leaves < 1 mm wide, most in fascicles of 5 (rarely fewer)4
3. Leaves (15–)20–30 cm × 1.2–1.5 mm, vertically pendulous, seed cones ovoid-conical*P. lumholtzii*
- Leaves (4–)6–12(–14) cm × 0.9–1.3 mm, seed cones ovoid*P. chihuahuana*
4. Leaves 6–15 cm × 0.5–0.9 mm, seed cones opening wide (90°)*P. leiophylla*
- Leaves 9–15 cm × 0.9–1 mm, seed cones opening slightly (<90°)*P. georginae*
5. Leaves mostly in fascicles of 36
- Leaves mostly in fascicles of 57
6. Leaves 15–20 cm × 0.7–0.9 mm, seed cones ovoid-elongate or conical*P. herrerae*
- Leaves 17–28.5 cm × 1.3–1.9 mm, seed cones ovoid*P. luzmariae*
7. Leaves lax or rarely rigid, < 1 mm wide, seed cones (2.2–)2.5–7.3 cm long 8
- Leaves rigid, (17.5–)19–30 cm × 1.0–1.7 mm, seed cones 4–7(–9) cm long *P. oocarpa*
8. Leaves 10–16 cm × 0.5–0.8 mm, seed cone peduncles 1.5–4.5 cm long *P. praetermissa*
- Leaves 14–20 cm × 0.6–0.9 mm, seed cone peduncles 0.7–1.8 cm long 9
9. Leaves 14–18 cm × 0.6–0.7 mm, seed cones 5.5–7.3 cm long *P. jaliscana*
- Leaves (12–)17–20(–22) cm × 0.8–0.9 mm, seed cones (2.2–)2.5–3(4.0) cm long *P. vallartensis*

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