Pinus tecunumanii Eguiluz & J. P. Perry

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PINACEAE (PINE FAMILY)

Pinus patula ssp. *tecunumanii* (Eguiluz & Perry) Styles, *Pinus oocarpa* var. *ochoterenae* (Mart.)

Pino colorado, pino de las Sierras, pino ocote, pino rojo (Gutiérrez 1996)

Pinus tecunumanii is a closed-cone pine that occurs from Chiapas, Mexico (17°02'N) to central Nicaragua (12°42'N) in a series of disjunct populations (Dvorak and Donahue 1992). The species' geographic range can be divided into two large subpopulations based on subtle morphologic and adaptability differences: high-elevation populations that occur from approximately 1500 to 2900 m elevation, and low-elevation populations that are found at 450 m to 1500 m (Dvorak and others 1989).

Mature trees from high-elevation populations can reach 55 m in height and more than 100 cm d.b.h. on the deep, fertile soils of the montane cloud forests of Guatemala and Honduras (Eguiluz and Perry 1983). The tree is easily recognized by its small crown and its thick, gray, furrowed bark near the base with thin, gray, flaky bark higher on the stem. It has a very straight stem form, small cones borne in ones and twos on long, thin peduncles, and needles in fascicles of mainly four (Eguiluz and Perry 1983). *Pinus tecunumanii* trees from high-elevation populations are often found in areas with greater than 1500 mm of annual rainfall and grow in association with *Liquidambar styraciflua* L., *P. ayacahuite* Ehren., *P. maximinoi* H. E. Moore, *P. oocarpa* Schiede ex Schlechtendal, and *Quercus* spp. The growth rate of trees of *P. tecunumanii* in high-elevation areas ranges from 5 to 8 m^3 per ha per year.

Trees from the low-elevation populations seldom grow larger than 30 m in height and 60 cm d.b.h., have less flaky bark and poorer stem form than their high-elevation counterparts, and often produce cones in clusters of threes or fours. On dry sites in Honduras and Nicaragua, *P. tecunumanii* is practically indistinguishable from *P. oocarpa* and, some taxonomists refer to the low-elevation sources as *P. oocarpa* var. *ochoterenae* (Squillace and Perry 1992). Trees from low-elevation sources grow in areas with 1000 to 1800 mm annual precipitation in association with *P. oocarpa*, *P. caribaea* var. *hondurensis* (Sénécl) Barr. and Golf., and *P. maximinoi*. The growth rate of trees from the low-elevation sources in Central America is approximately 3 to 8 m^3 per ha per year.

Molecular marker studies show a clear separation between high- and low-elevation populations of *P. tecunumanii* and suggest that the species may share a close evolutionary history with both *P. oocarpa* and *P. caribaea* var. *hondurensis* (Furman and others 1996). The Central America and Mexico Coniferous Resources Cooperative (CAMCORE), North Carolina State University, is keeping the two groups of *P. tecunumanii* separate for breeding purposes (Central America and Mexico Coniferous Resources Cooperative 1996). It is widely assumed, based on field observations, that *P. tecunumanii* crosses naturally with *P. patula* var. *longipedunculata* Loock ex Martínez, *P. oocarpa*, and *P. caribaea* var. *hondurensis* in its native habitat where the species occur sympatrically. Artificial hybrid crosses between *P. tecunumanii* and *P. caribaea*, *P. elliottii*, *P. oocarpa*, and *P. patula* have been made successfully by several institutions in the tropics and subtropics (Mather 1996, Nikles and Robinson 1989, Stanger 1994).

Pinus tecunumanii has a yellowish wood much like some of the southern pines from the United States. In natural stands, trees that averaged at least 30 years old had wood density that ranged from 0.510 g per cm^3 to 0.560 g per cm^3 (Eguiluz and Zobel 1986). In Mexico and Central America the wood is used for saw timber, framing, pallets, broom sticks, fuel wood, and kindling for fires.

Since 1980, *P. tecunumanii* has been the most widely tested Mexican and Central American pine in the tropics and subtropics, with more than 50 provenances and the progeny from 2,000 mother trees in field trials (Dvorak 1993). Results from the international series of trials established by CAMCORE indicated a 32-percent difference in volume performance between the best and worst high-elevation source of *P.*

tecunumanii (Central America and Mexico Coniferous Resources Cooperative 1997). The best high-elevation source was from San Jeronimo, Guatemala, and the best low-elevation sources were from Villa Santa, Honduras and Yucul, Nicaragua (Hodge and Dvorak 1998).

The low-elevation sources of *P. tecunumanii* are superior in productivity to high-elevation sources in Colombia, but these differences do not appear in South Africa. *Pinus tecunumanii* is only planted on a small scale as an exotic in places like Colombia and South Africa because of the high levels of stem breakage (Dvorak and Raymond 1991, Parfitt 1996). The wood of *P. tecunumanii* from both high- and low-elevation sources, when planted as an exotic, has proven to be acceptable for sawn timber, kraft, and thermomechanical pulp (Malan and Hoon 1991, Wright and others 1995).

With the possible exception of the Rancho Nuevo, Chiapas provenance, *P. tecunumanii*, shows little resistance to frost when planted as an exotic (Dvorak and Donahue 1992). The low-elevation *P. tecunumanii* sources appear to be more drought tolerant than *P. elliottii* on the sandy soils of Zululand, South Africa (Mather 1996), but are much more susceptible to *Phytophthora* root rot on the wetter sites than either *P. elliottii* or *P. caribaea*. *Pinus tecunumanii* appears to be much more resistant to *Sphaeropsis sapinea* in southern Brazil than does either *P. greggii* or *P. patula*.

In Central America and southern Mexico, *P. tecunumanii* produces male and female strobili from December through March and cones can be collected from January through March, 22 to 24 months later. Cones are usually borne in as many as three flushes, but those collected in mid-season (February) seem to have the highest percentage of filled seed. Cones should be collected when they are brown. If collected too green, the seeds have a pinkish tinge and germinate poorly. Cones are collected by tree climbers with poles. The poles have an S-shaped blade at the end, and cones are cut or broken from the branches. *Pinus tecunumanii* cones can be placed directly in the sun or an oven to open. Success in opening has even been achieved by placing cones inside a vehicle and turning on the heater. To oven-dry cones, maintaining a temperature of 40 °C for 24 hours is recommended.

The high-elevation sources of *P. tecunumanii* are very shy cone producers in Mexico and Central America. A large tree (40 m tall) may have fewer than 50 mature cones that average only six filled seeds each (Dvorak and Lambeth 1993). Trees from low-elevation sources are generally more prolific cone producers and average approximately 30 filled seeds per cone. The maximum seed potential for cones from high- and low-elevation collection sites is 90 and 95, respectively (Dvorak and Lambeth 1993). Seeds from trees of high-elevation populations tend to be smaller than those from low-elevation sources. The average number of seeds per kg for high-elevation populations is 88,250; for low-elevation, 76,215.

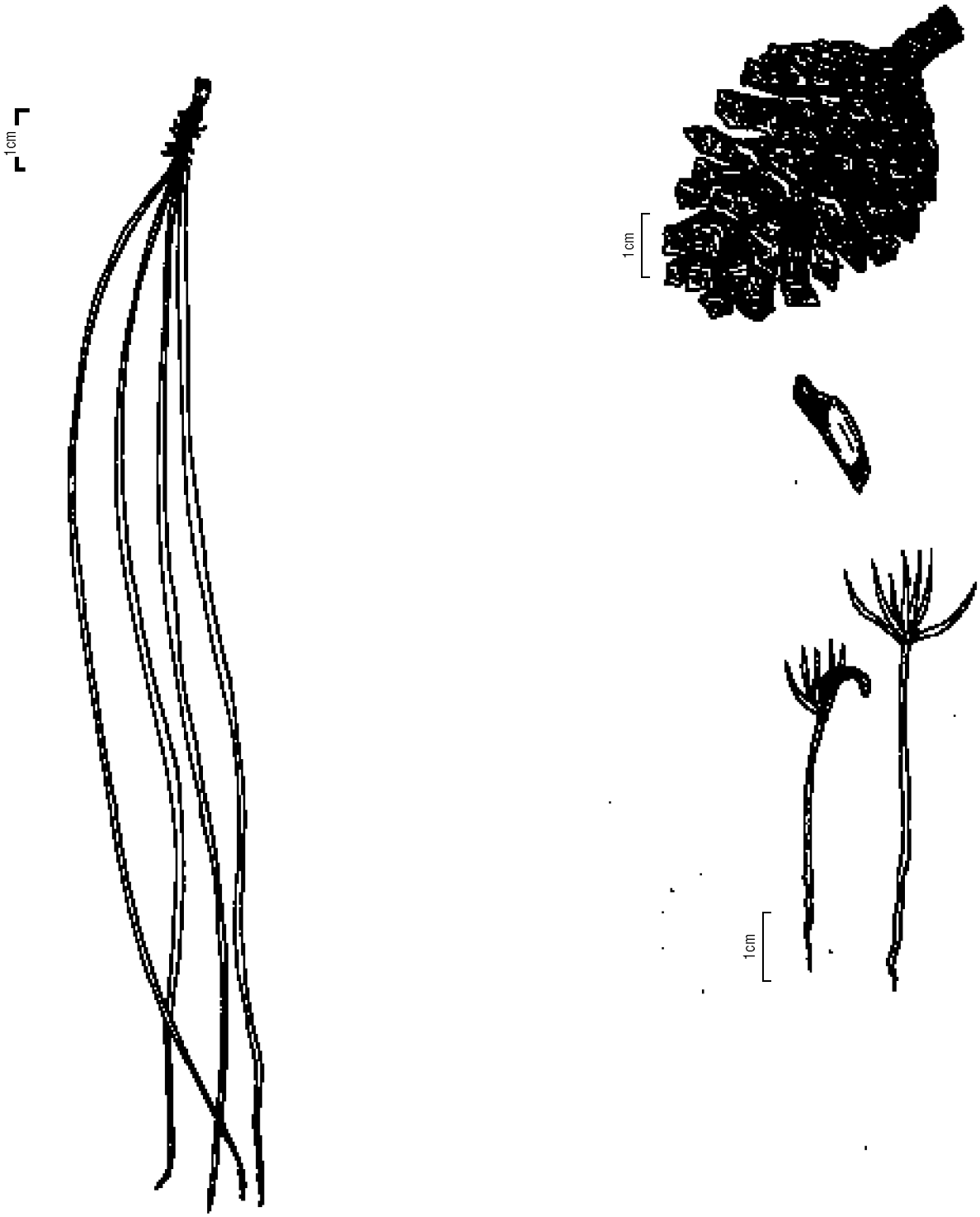
Flowering time and duration of *P. tecunumanii* grown as an exotic has not been well-studied. However, in South Africa, a 2- to 3-week difference in flowering periods appears between clones of high- and low-elevation material when grown in the same seed orchard. In Colombia, flowers appear throughout the year, with a peak in August. Cone and seed production of *P. tecunumanii* is poor near the equator and northern latitudes but improves in southern latitudes. Regions for cone and seed production are best between 17° and 28°S in coastal Australia, Brazil, South Africa, and the highlands of Zimbabwe (Dvorak and Lambeth 1993). Seed orchards of *P. tecunumanii* established in Brazil, Costa Rica, Colombia, South Africa, and Zimbabwe are just beginning to produce seeds. In Colombia, studies are being implemented to determine how applications of gibberellins affect flowering. Scions of *P. tecunumanii* have been successfully grafted onto root stock of *P. elliottii* in South Africa (Mather 1996) and of *P. patula* and *P. oocarpa* in several regions. Grafting *P. tecunumanii* scions onto *P. taeda* L. rootstock failed in Brazil.

Seed storage and handling procedures for *P. tecunumanii* are similar to those used for many of the other hard tropical pines. Seeds stored in a plastic, air-tight container at 4 °C and with a moisture content of 6 to 9 percent should remain viable for years. However, *P. tecunumanii* has a thin seed coat that can be cracked, chipped, or split easily by rough handling, and care must be used during seed processing.

Seeds of *P. tecunumanii* can be easily germinated when laid on moist filter paper in petri dishes and placed in a germinator for 7 days. The seeds also readily germinate when placed in open boxes that contain moist sand. Normal germination for seeds from natural stands is approximately 75 percent. Commercial forestry programs sometimes soak seeds in water at room temperature for 24 hours before sowing. Germination begins 7 to 10 days after sowing.

Pinus tecunumanii will grow successfully in a number of different soil media including decomposed *P. patula* bark. Soil that is high in organic matter and holds water for long periods tends to slow or stunt the growth of *P. tecunumanii* (Dvorak 1985). The development and architecture of the root system is strongly influenced by container shape and size. The species is very susceptible to J-rooting, and trees have been observed falling over from root strangulation after 2 to 3 years in the field in Brazil, Colombia, Venezuela, and southern Africa when planted as an exotic. *Pinus tecunumanii* does not appear to produce a deep taproot (Dvorak 1990). To improve root development and seedling quality, nurseries are beginning to use large containers with ridged interiors and to outplant seedlings at a small size, usually between 12 to 15 cm shoot

height. Cuttings from seedling stools root easily in most tropical environments (Easley and Lambeth 1989, Osorio 1992), and large improvements in productivity and uniformity will be achievable through replication of the best clones.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