Pinus oocarpa Schiede ex Schltdl.

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PINACEAE (PINE FAMILY)

No synonyms

Chaj, chictaj, ichtaj, ocote, ocote chino, pino, pino amarillo, pino avellano, pino colorado, pino ocote, pino prieto, tocj (Gutiérrez 1996, Martínez 1979, Perry 1991, Peters 1977, Zamora 1981)

Pinus oocarpa is a closed-cone pine native to Mexico and Central America (Perry 1991). It has a geographic range of 3000 km from Sinaloa, Mexico (28°20'N latitude) to central Nicaragua (12°40'N latitude) and is the most common pine in the southern half of Mexico and Central America. It constitutes approximately 45 percent of the pine forests of Chiapas (Zamora 1981), 50 percent of Guatemala, 66 percent of Honduras (Wolffsohn 1984), 90 percent of Nicaragua (Greaves 1979), and 60 percent of El Salvador. It is also found in several locations in the interior highlands of Belize.

Pinus oocarpa is phenotypically an extremely variable species in its native environment because it has evolved under diverse climatic and edaphic patterns over its 3000-km geographic distribution. It occurs from 350 to 2500 m elevation in Mexico and Central America but reaches its best development between 1200 to 1800 m. Along the northwest coast of Mexico it occurs in areas with as little as 600 to 800 mm of annual rainfall (Pérez de la Rosa 1998). In southern and eastern Mexico and most of Central America it generally occurs in areas of 1000 to 1500 mm of annual precipitation with dry seasons of up to 5 months. In some locations where *P. oocarpa* is found, like Ocotal Chico, Veracruz, Mexico, annual rainfall amounts exceed 2250 mm. *Pinus oocarpa* is most often found on shallow, sandy clay soils of moderate soil acidity (pH 4.0 to 6.5) that are well drained. The species distribution appears to be very dependent on the existence of frequently occurring fires.

Trees of *P. oocarpa* can be recognized in their native habitats by their irregular crowns, thick, gray, platy bark, ovoid-shaped cones with a large, thick peduncle, and needles in fascicles of five. On deep, well-drained soils and with good rainfall regimes, *P. oocarpa* is a medium-to-large tree about 20 to 35 m in height and 45 to 80 cm d.b.h. The species reaches its best development in eastern Guatemala, Honduras, and northern Nicaragua where soils are deep and annual rainfalls are above 1200 mm. The growth rates of *P. oocarpa* in natural stands in these regions are approximately 3 to 4 m^3 per ha per year. In northern Mexico, where the climate is drier than in most parts of Central America, trees reach only 10 to 15 m height and are generally poorly formed. Trees are also often less than 10 to 12 m height where they grow on shallow, eroded soil on ridge tops, or at elevations below 800 to 900 m (Zamora 1981). The growth rate of *P. oocarpa* in these dry regions is approximately 1 m^3 per ha per year.

Pinus oocarpa crosses naturally with both *P. caribaea* var. *hondurensis* (Sénécl) Barr. & Golf. and *P. tecunumanii* Eguiluz & J. P. Perry, and a number of hybrid swarms exist in Central America (Furman and others 1996, Squillace and Perry 1992). Artificial crosses among all three pine species have been successfully made for years in Queensland, Australia (Nikles 1989).

The wood of *P. oocarpa* is whitish yellow. Wood density is moderate and provenance averages range from 0.450 to 0.550 g per cm^3 for trees 30 to 60 years of age throughout Mexico and Central America. Local industries and farmers have used the wood for plywood, construction lumber, packing boxes, soft drink boxes, broomstick handles, Popsicle sticks, railroad ties, and posts (Zamora 1981). However, its greatest use in the region is for fuel wood and kindling (ocote) as well as for resin production.

Since the early 1970's, *P. oocarpa* has been extensively studied for provenance variation in adaptability and productivity (Dvorak and Donahue 1992, Greaves 1979). Results of the field studies suggest that provenances from Honduras and the Sierra de las Minas region of eastern Guatemala are generally the best volume performers (Birks and Barnes 1990). Outstanding sources of what was once called *P. oocarpa* from Nicaragua, like Camelias, San Rafael del Norte, and Yucul,

have now been classified as *Pinus tecunumanii* (McCarter and Birks 1985). Similarly, what was once called *P. oocarpa* var. *ochoterenae* on the Mountain Pine Ridge, Belize (McCarter and Birks 1985), and in Chiapas, Mexico, is now called *Pinus tecunumanii* (Dvorak and Raymond 1991) even though not all taxonomists agree with the reclassifications (Squillace and Perry 1992).

An estimated several hundred thousand hectares of *P. oocarpa* are planted in the tropics, primarily Brazil, as an exotic. The productivity of the species as an exotic ranges from 10 to 18 m^3 per ha per year across many sites, with wood density of 0.420 to 0.500 g per cm^3 at 10 to 15 years of age. Continued interest in *P. oocarpa* as a plantation species declined in the early to mid-1980's because provenances of *P. tecunumanii* and *P. caribaea* var. *hondurensis* were found that were superior (Crockford 1990, Dvorak and others 1993, Dvorak and Shaw 1992). The disadvantages of *P. oocarpa* as a plantation species include its slow initial growth on some sites, poor wind firmness, susceptibility to nutrient deficiencies and needle diseases, and a relatively light crown that permits a continuous weedy understory to develop, increasing the fire danger. Recent problems of stem breakage in *P. tecunumanii* have once again stimulated interest in planting more *P. oocarpa*. Growers like its good wood quality, its ability to sprout from cut stumps, and the ease with which it vegetatively propagates, as well as its usefulness in developing hybrids with other tropical and subtropical pines.

Flowering of *P. oocarpa* begins in November in most of Central America and Mexico, and reaches its peak in late December and early January. Flowering always begins earliest in the driest areas or at the lowest elevations (Zamora 1981). Changes in climatic patterns, such as those brought about by El Niño, can cause flowering to occur as early as September in Central America (Houkal 1983). In northern Mexico, cones of *P. oocarpa* occur singly or occasionally in clusters of two or three (Pérez de la Rosa 1998). In southern (Chiapas) Mexico and Central America, cones are usually borne in clusters of three or four and the main crop matures from January through March, even though some cones can be found ripening on the tree most of the year. Generally there are several flushes of cones from December through April, but the ones that mature during February and March contain the most filled seeds. Because seeds usually fall to the ground in March, April, and May just prior to the onset of the rainy season (Wolffsohn 1984), old cones from past-year crops should not be collected.

In Central America and Mexico, mature cones are collected by tree climbers with poles. The poles have an S-shaped hook or sharp blade at one end, which is used to force the cones from the branch. At harvest, cones have a fresh weight moisture content of 20 to 25 percent (Robbins 1985). Cones can be placed directly in the sun to air-dry, the most common method used in Mexico and Central America. The amount of sunlight and the air temperature affect when cones open, usually in 3 to 5 days. During the air-drying process, the cones should be raked or moved around so all sides are exposed to the sun. Cone scales not exposed to the sun may remain closed. Cones stored in burlap bags or sugar sacks for several weeks may case harden and remain closed even when subjected to high temperatures.

Cones of *P. oocarpa* will open quickly when placed in a kiln or tobacco drying barn at 40 to 44 °C for 24 hours. *Pinus oocarpa* can withstand kiln temperatures of 50 °C for 12 to 18 hours without loss of viability (Robbins 1985). Higher temperatures are not recommended. Because the seeds have thin coats that can be easily split or cracked, great care is needed if dewinging the seed by hand.

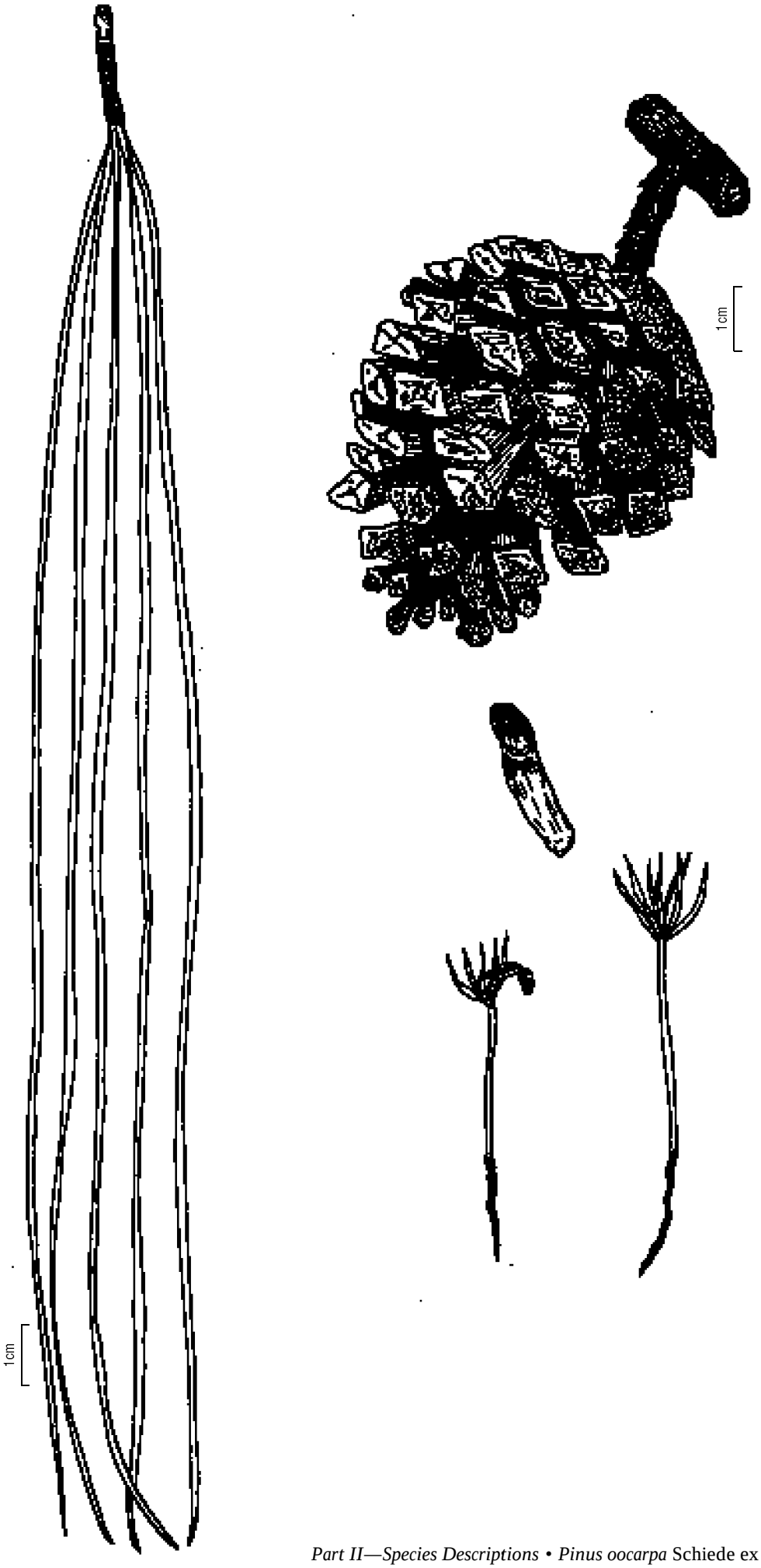
The seed potential of *Pinus oocarpa* is approximately 140 seeds per cone (Houkal 1983). Seed set is relatively low in natural stands. Several studies in Guatemala and Honduras revealed approximately 15 to 35 filled seeds per cone or a seed efficiency rate of about 12 to 30 percent (Houkal 1983, Hudson and others 1981, Ordoñez 1981, Robbins 1983, Wilkinson 1983). The number of seeds per kg for *P. oocarpa* was between 43,600 and 49,000 in Chiapas, Mexico (Zamora 1981), 51,000 in Honduras (Wolffsohn 1984) and 56,000 to 77,450 in Guatemala. In Guatemala, seed size was found to decrease with increasing elevation.

When *P. oocarpa* is planted as an exotic near the equator, seed yields are poor but improve with increasing latitude. In Colombia (2°N latitude), Arce and Isaza (1996) found only seven filled seeds per cone in stands 12 to 21 years of age established between 1360 and 1800 m elevation. *Pinus oocarpa* averaged approximately 25 filled seeds per cone in Venezuela (10° to 11°N latitude) in stands 10 to 12 years of age when established above 800 m elevation. The seed production of *P. oocarpa* is usually better than that of *P. caribaea* var. *hondurensis* at tropical low latitudes.

Seeds of *P. oocarpa* can be stored for a number of years at 4 °C if moisture content has been reduced to 6 to 9 percent after collection and the seeds are packaged properly. Commercial forestry nurseries soak seeds for 24 hours before sowing to improve both the rate and the percentage of germination. Cold stratification of seeds is unnecessary before germination for most provenances. However, some level of cold stratification may prove beneficial for the most northern sources of the species in Mexico.

Seeds will begin to germinate in 7 to 10 days using standard laboratory techniques (germinating seeds on moist filter paper in petri dishes) or nursery techniques (germinating seeds in moist sand). *Pinus oocarpa* seedlings usually reach a

field planting height of 20 to 25 cm in 5 to 7 months. Plants tend to become bushy shortly after field establishment and remain that way for several years before a dominant terminal leader develops. Weeds should be well controlled during this period. Seedlings will resprout after heavy browsing by deer, and saplings will resprout from the base after either freezes or fires of low intensity. *Pinus oocarpa* should not be considered a cold-tolerant species.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