Cedrela tonduzii C. DC.

E.M. FLORES
Academia Nacional de Ciencias de Costa Rica, Costa Rica

MELIACEAE (MAHOGANY FAMILY)

Cedrela pacayana Harms (Notizblatt des Botanischen Gartens und Museums zu Berlin-Dahlem 11: 784. 1983)

Cedar, cedrillo, cedro, cedro cebolla, cedro colorado, cedro dulce, cedro granadino, cedro macho, cedro pochote, West Indian cedar

Cedrela tonduzii is distributed from Chiapas, Mexico to Panama in Central America. It is a canopy-emergent species in the premontane and lower montane humid and very humid tropical forests. The species is common on the slopes of the Central Volcanic Mountain Range and the Talamanca Mountain Range (Breedlove 1986, Hazlett 1979, Molina 1975).

Cedrela tonduzii is a tree that reaches 30 to 45 m in height and 80 to 100 cm d.b.h., although sometimes it may reach greater diameters (up to 180 cm). The bole is straight and symmetrical. The tree crown is open, with thick ascendant branches produced at a low height. The branchlets have sporadic small lenticels. The bark is rough; vertically fissured; and brown, reddish brown, or dark grayish brown, depending on the light intensity to which it is exposed. The bark exfoliates in small, irregular plates. The mean thickness is 1.8 to 2.0 cm. Internally it is mucilaginous and pink or reddish colored. Leaves are spirally arranged, large, compound, pinnate, light green, glaucous abaxially; petioles are greenish brown, pubescent, terete, lenticellate at the proximal end. It grows well in areas with moderate declivity and may be riparian. The species grows in fertile soils, with good or moderate drainage. Commonly, these soils have a volcanic origin and the sopes are 51. The elevational range varies from 1000 to 2800 m. In its area of distribution, the temperature range is 6 to 20 °C, and the annual rainfall is 2400 to 8000 mm.

Sapwood is yellowish gray in green condition; heartwood is bright, reddish orange. Sapwood turns grayish orange after air drying, heartwood changes to bright red. The wood oxidizes and darkens when exposed to light. Growth rings are easily seen and are demarcated by thin, regular, brown stripes. The wood is light and the basic specific gravity is 0.36 to 0.41, varying with the origin. The mean green weight is 620 kg per m^3 with 67 percent moisture content. The oven-dried wood weighs 392 kg per m^3. The wood has a straight grain, high luster, and medium texture. The wood has excellent working properties; it is easy to saw, brush, lathe, and sand (Llach 1971, Richter 1971). The rate of drying is fast; it dries without visible defects. The contraction ratio is moderate and dimensional changes are uniform. It is classified as a C-type structural wood. The natural durability of the timber is low, and its preservation is difficult (Llach 1971, Richter 1971). Chemical impregnation is recommended (Richter 1971). The Peteri's coefficient of flexibility is 42 and the Runkel factor is 0.26; the wood is very good for making paper (Llach 1971, Richter 1971). The species provides most of the wood used in the carved trays sold by the Costa Rican farmers along the South InterAmerican Highway. The wood is currently used to make high-quality furniture, cabinets, casts, and instruments. It is also used in carpentry, interior and general construction, and veneers (Llach 1971, Richter 1971). The boiled bark provides a maroon dye that may be used to stain cotton fibers (Acuña and Rivera 1990). The species is also grown as an ornamental.

The species is monoecious. The tree blooms in April and May and sometimes June. The number of flowers and inflorescences varies from one tree to another in the same area. Floral anthesis is not synchronized between inflorescences of the same tree and phenologic synchrony is moderate among individuals of a population. The species is dichogamous. Pollination is entomophilous and the probable pollination vectors are moths (palaenophily). Flowers are grouped in large, ramified, terminal or subterminal panicles, 15 to 30 cm long, generally smaller than the leaves. Terminal branchlets are usually simple dichasia, and each inflorescence may have as many as 1,000 flowers. Flowers are unisexual with vestiges of the opposite sex, actinomorphic, synsepalous, apopetalous, pentamerous, short-petiolated, and pubescent. Male flowers have

long stamens and yellow, apiculate, fertile anthers; female flowers have small, brown, nonfunctional anthers. The fruit is a pendulous capsule, pentasepticide, elongated, obovoid, with conspicuous lenticels, 5 to 10 cm long. It is green during development and brown when mature. Fruits mature and dehisce, liberating the seeds, in June and July. Fruit abscission takes place several weeks after dehiscence. There are 25 to 30 fertile seeds per fruit. Seed dispersal is anemochorous; they are mobilized according to wind direction. The seed is winged, brown or reddish brown, and 3.0 to 5.5 cm long including the wing.

Seeds are collected in the tree (partially open fruits) or on the ground. Damaged or malformed seeds must be discarded. Of collected seeds, 65 to 70 percent exhibit embryo damage. A low percentage (5 to 8 percent) show developmental anomalies. In most such cases, germination is null. Seeds average 84,600 per kg. Water content in fresh seeds is approximately 32 percent. Seed viability is lost rapidly. Although the species has been studied less than *C. odorata,* seeds can probably be stored following the same procedure: storage in a dry atmosphere with a temperature range of 3 to 5 °C.

Seeds must be soaked in running water for 24 hours to obtain complete imbibition. Seeds germinate in 6 or 7 days. Selected fresh seeds have an 85 to 90 percent germination rate, which varies with seed source. Germination is epigeal and the seedling is phanerocotylar.

Seeds germinate well if sown in sand beds; 20 days later, the seedlings must be transplanted to plastic bags. The use of fertilizers rich in potassium improves seedling vigor and growth. Seedlings grow well under full light but tolerate partial shade. Three-month-old seedlings reach a height of 20 to 25 cm and bear several compound leaves, with helical distribution.

The seedling and sapling behavior in plantations is not well known; however, the species is very susceptible to *Hypsipyla*, *Sematoneura atrovenosella,* and other microlepidopters that attack the Meliaceae (Becker 1976). Several microlepidopters are associated with the genera *Cedrela, Carapa,* and *Swietenia.* Their larvae cause conspicuous shoot damage and drastically limit the establishment of the species in plantations. The young shoots of *Cedrela tonduzii* host *Hypsipyla grandella* (Pyralidae), *Sematoneura atrovenosella* (Pyralidae), and *Phyllocnistis meliacella* (Gracillariidae) larvae. *Hypsipyla grandella* larvae damage young shoots and fruits. Some Cerambycidae are predators of the young shoots causing stem bifurcation, and several coleopterans in the family Scotylidae may be predators of the seedlings. This susceptibility limits the tree's use in monospecific plantations. Leaf spot (*Cercospora* sp.) and powdery mildew (*Oidium* sp.) may be parasites on the leaves. *Sclerotium*, *Rhizoctonia,* and *Fusarium* may attack the seedlings. In the nursery, *C. tonduzii* has better growth than *C. odorata* during the first 6 months. Its behavior in plantations above 1000 m has not been documented.

ADDITIONAL INFORMATION

The genus *Cedrela* was described more than 250 years ago by Patrick Browne in his treatise on the natural history of Jamaica (Browne 1756). The first validated species appeared shortly thereafter in Linnaeus' book Systema Naturae (Linnaeus 1759). The aromatic odor of the wood gave rise to cedar, a name used by the Spaniards to name the genus because of its similarities to the true cedars of the Old World. The generic name is a diminutive of *Cedrus*, which means small cedar (Pennington and Styles 1975). The species name honors the naturalist Adolphe Tonduz (Type: Pittier 11945. Costa Rica, El Copey, fl., fr.).

Leaves have five to nine short-petiolulated leaflet pairs; leaflets are lanceolate or oblong-lanceolate, with entire margins; acuminate, acute or obtuse apexes; and oblique bases; leaflet blades are membranaceous or slightly coriaceous, abaxially tomentose or pilose; the upper surface is glabrous or pubescent along the midvein, hypostomatic, with stomata of the paracytic type (rubiaceous). Venation is eucamptodromous; midvein is thick, straight; secondary veins are opposite, semiopposite, and sporadically alternate.

Unisexual flowers have calyx lobes that are deltaic, puberulent; corolla is creamy; and petals have imbricate aestivation, oblong or elliptic-oblong, fleshy, adnate to the gynophore by a carina, along the proximal one-third. Androecium is pentamerous; anthers are free, filaments basally adnate to gynophore. Female flowers have a superior, syncarpic, pentalocular, glabrous, globose or ovoid ovary. Placentation is axilar, and the ovary has 8 to 14 ovules per locule; the style is short and the stigma discoid, with glandular papillae. Male flowers have a narrow ovary with locules, but ovules are vestigial; style is narrow, stigma lacks glandular papillae. Ovules are anatropous, bitegmic, and crassinucellate.

The fruit's pericarp is woody and the exocarp is brown, with lenticels. The mesocarp is slightly conspicuous and woody as is the endocarp. The latter forms the septa and surrounds the central columella. There are many transverse fibers reinforcing septa structure; at the ends and around the columella, fibers are longitudinal. In the open capsule, the columella has five conspicuous wings (corresponding to the ovary septa). It is woody and has many scars which correspond to the funicula attachment at the placental areas. The fruit valves are also woody; they open basipetally during fruit dehiscence.

The seed's funiculus is short and subapical. The seedcoat is formed by testa and tegmen; those are not lignified and are undifferentiated; the tegmen is not specialized. The wing

develops from a chalazal protuberance. The endosperm is oily. The embryo is straight, fleshy, soft, and whitish or creamy. The cotyledons are extended, and the hypocotyl is conspicuous.

During germination, radicle protrusion takes place throughout the hilum. The hypocotyl completes its emergence at 8 to 9 days; the cotyledons emerge in 10 to 11 days. They are ovoid, subsessile, foliaceous, dorsiventral, with entire margin, acute or obtuse apex, base wide, oblique. Eophylls are opposite, semi-opposite, sometimes alternate, supracotyledonary, pinnately.

On the forest floor, the logs exhibit traces of damage produced by termite attack after 12 months; 2-1/2 years later the damage is severe. When wood remains above ground level, fungal attack is light at 2-1/2 years; if it is placed at ground level or underground, the damage is light at 12 months and severe after 2-1/2 years (Bultman and Southwell 1976).

Sematoneura atrovenosella larvae live inside the fruits and destroy most seeds (Becker 1976). The fruit pericarp shows circular orifices; the interior of the fruit contains insect excrements, seed remains, and white silky filaments. The young leaves are attacked by *P. meliacella* larvae established in the abaxial surface (Becker 1976). They absorb the sap and form galleries which may reach the midvein as well as the secondary veins. Before pupating, the larvae build a pupal chamber, turning the leaflet abaxially and fixing the margin to the leaflet blade with a creamy, silky glue (Becker 1976).

Different species in the Bostrychidae, Cerambycidae, Platypodidae, Curculionidae, and Brentidae are wood borers and decomposers. Adult female oviposition occurs in the wood of fallen trees; the larvae develop inside the wood, decompose it (especially the sapwood), and eventually rot it. The scale (*Pinnaspis* sp.) is a common pest, as well as leaf-cutting ants (*Acromyrmex* spp.), which defoliate seedlings, saplings, and adult trees (Flores 1996).

The species seems suitable for natural forest management (lower montane forest), mixed plantations, and agroforestal systems, and as a threatened species deserves attention as a biodiversity element. In the genus *Cedrela*, several species have compounds with biological activity (*C. odorata* L., *C. fissilis* Vell.) (Taylor 1981); the chemistry of *C. tonduzii* has been only partially explored, but leaf extracts may reduce the growth of cornborer larvae (*Ostrinia nubilalis*) (Arnason and others 1993).


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