Pentaclethra macroloba (Willd.) Kuntze

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FABACEAE (BEAN FAMILY)

Acacia macroloba Willd. (Species Plantarum. Editio quarta 4[2]: 1054; 1806); *Mimosa macroloba* (Willd.) Poir. (Encyclopedie Methodique. Botanique...Supplement 2 [1]: 66; 1811); *Acacia aspidioides* G. Meyer (Primitiae Florae Essequeboensis...165; 1818); *Pentaclethra filamentosa* Benth. (Journal of Botany; second series of the Botanical Miscellany 2 [11]: 127-128; 1840); *Pentaclethra brevipila* Benth. (Journal of Botany; second series of the Botanical Miscellany 2 [11]: 128; 1840); *Cailliea macrostachya* Steud. (Flora 26: 759; 1843); *Entada werbaeana* J. Presl. (Epimeliae Botanicae 206; 1849)

Bois mulatre, carbonero, fine-leaf, gavilán, koeroebahara, koeroeballi, kooroballi, koroballi, kroebara, mulato, oil bean tree, palo de aceite, palo mulato, paracachy, paraná-cachy, paroa-caxy, pracaxy, quebracho, sangredo, sangredo falso trysil, wild tamarind (Flores 1994f, Record and Hess 1949, Standley 1937)

Pentaclethra macroloba grows naturally from Nicaragua to the Amazon, including the Guianas and the West Indies (Brako and Zarucchi 1993, Ducke 1949, Schery 1950). It is abundant in coastal lowlands with moderate slope. *Pentaclethra macroloba* is formed by three neotropical disjunctive populations (Hartshorn 1983b). The largest is found in the Amazon lowlands of the Atlantic coast from northeast Venezuela to the Guianas and includes Trinidad and Tobago islands. A second population inhabits western Colombia (Departamento de Chocó) and the humid lowlands of Darien Province, Panama. The last group is located in the Atlantic lowlands of southeast Nicaragua, Costa Rica, and western Panama (Hartshorn 1983b). In the forest, the species grows associated with *Carapa guianensis* (subdominant in the canopy), *Pterocarpus officinalis* Jacq., *Stryphnodendron microstachyum* Poepp., and the palms *Astrocaryum alatum* H.F. Loomis and *Iriartea gigantea* H. Wendland ex Burret (Flores 1994, Hartshorn 1983).

Pentaclethra macroloba is a beautiful, fast-growing, emergent tree, which is dominant in the canopy of the humid tropical forests. It reaches 30 to 35 m in height and 130 cm d.b.h. The bole is cylindrical and grooved at the base; in seasonally flooded places, the tree develops small buttresses. Trees with a bole above 70 cm d.b.h. usually have hollow piths. Branches are rough and strong, and the foliage is feathered. Young shoots are ferruginous (Flores 1994f, Schery 1950). The bark is smooth and grayish brown, with horizontal lenticels. Internally, it is granular and pinkish. Its average thickness is 2 to 3 mm. The phyllotaxis is spiral. The leaves are long, shiny, biparipinnate, stipulate, with a small structure at the distal end. Species density in the forest is close to 50 percent, but decreases with sloping; it is common near rivers, creeks, and seasonally flooded zones. The species grows well in alluvial or residual soils derived from basalts. It is also found in swampy or poorly drained areas with acid soils. In some zones, the tree grows on volcanic rocks covered by a thin layer of volcanic soil. The elevation range of the species varies from 0 to 600 m; the temperature range is 24 to 35 ^{o}C, and the average annual rainfall is more than 3500 mm.

Most cambial activity and wood production in the tree occurs in the dry season (December through April) when no flowers are produced (Hazlett 1987). Annual rings are outlined by dark fibrous zones. Heartwood and sapwood are remarkably different. Green sapwood is whitish while heartwood is reddish brown. Air-dried wood has pink sapwood and reddish brown heartwood. The wood has straight or interlocked grain, medium texture, moderate luster, and lacks figure; however, it has an attractive appearance. The wood has high quality; it is heavy (green weight 1090 to 1230 kg per m^3 with 120 to 124 percent moisture content; basic specific gravity is 0.51 to 0.65). Volumetric contraction is moderate, and the tangential contraction:radial contraction ratio is normal. The wood corresponds to the structural type B (Herrera and Morales 1993, Record and Hess 1949). Moisture content is 12 percent. Static flexion is medium; parallel compression of

fibers is low; perpendicular compression is medium. Shearing is medium, and Janka hardness (lateral and end strength) is almost medium. It is easy to saw and polishes well. Air-drying is easy and moderately fast (Herrera and Morales 1993). The heaviest wood corresponds to individuals from the extant population in the Atlantic lowlands of Nicaragua, Costa Rica, and Panama. In the Atlantic lowlands of Costa Rica, a subtype has been found: trees are taller, the bole does not bear branches in the basal third, the wood is darker, and wood quality is higher. The natural durability of the wood is moderate and preservation is easy. It resists the attack of subterranean termites from 6 to 7 years, but decays later. It is susceptible to fungal attack at or below ground level 1 year after cutting. Above the ground, rotting occurs 2 years later (Bultman and Southwell 1976).

It is a pretty timber with multiple uses. Several years ago, the Central American countries exported large amounts of this wood to Cuba and other countries where it was used to make telephone poles. The wood is currently used as a substitute for mahogany (*Swietenia macrophylla*); crabwood, empire andiroba or royal mahogany (*Carapa guianensis*); and anaconda or geiger tree (*Cordia alliodora* [Ruiz & Pav.] Oken) to make furniture, cabinets, doors, and window frames. It is also used to make pillars, beams, floors, stairway steps, railroad ties, lathed shapes, and parquet. In rural communities, the wood is used for bridge decking. The bark is a potential source of tannins for fur tanning use. The alkaloid paucine found in bark and seed should be studied to verify the toxicity and medicinal properties ascribed to it by South and Central American Indian groups (Allen and Allen 1981, Flores 1994f). Branches or trunks inadequate for industrial use have been used as firewood (Flores 1994f, Record and Hess 1949).

Pentaclethra macroloba may begin flowering and fruiting at 1 to 2 years. The species blooms primarily from April through May and July and August, although flowers are observed during the entire rainy season. The racemes have numerous flowers (about 200 flowers per raceme), but few fruits develop (Flores 1994f). Flowers are bisexual and monomorphic. They are clustered in dense racemes with a fleshy, spadiciform rachis. Inflorescences are 2 to 4 cm long. Flower maturation is mostly acropetal. The flower is small, sessile, pentamerous, and somewhat coriaceous. The species is cross-pollinated and several small insects are the probable pollinators. One to five flowers per inflorescence set a fruit. The main fruit crop appears in August and September; a minor crop appears in November and December; however, some fruits can be observed in other months.

The fruit is a dehiscent pod, pedicellated, linear, laterally compressed, obtuse at the apex, woody, 20 to 50 cm long, 4 to 6 cm wide, and 1 to 3 cm thick. The exocarp is thin, dull, dark brown, glabrous, and moderately exfoliating; the mesocarp is thick, fibrous, woody, and well vascularized by branches of the dorsal and ventral veins. The endocarp is slightly septate, dull, and light reddish brown. The pedicel is thick, woody, and 1 to 3 cm long. The pod has three to eight seeds. Pod dehiscence is explosive and seed dispersal is autochoric; it begins at the distal end and progresses basipetally along the ventral and dorsal sutures. As the valves move backward, the seeds are expelled 30 to 40 m away (Flores 1994f, Flores and Rivera 1989b).

The seed is ovate or obovate, and laterally compressed; faces are asymmetrical. The seedcoat is brown, dull coriaceous, and unitegmic; the tegmen is absent. The seed is classified as overgrown (Corner 1951) because its growth is limited by pod size. Seeds average 280 to 300 seeds per kg. The seeds contain a high lipid content with industrial potential. The fresh seeds have about 42 to 45 percent moisture content. Seed behavior is recalcitrant. Seeds do not tolerate dessication or drastic temperature fluctuations. They may be stored 4 to 6 days under ambient temperature (24 to 30 °C) and environmental moisture (above 90 percent air moisture).

Germination averages 90 percent, and it can be increased if damaged or faded seeds are discarded. Germination is hypogeal and seedlings are cryptocotylar (partially). Radicle protrusion takes place 8 to 10 days after sowing. Frequently, 10 to 11 insect larvae emerge through small holes on the adaxial surface of the cotyledons, which diminishes seed vigor. If the plumule is damaged, shoot development does not occur (Flores 1994f).

Seeds may be sown in greenhouse beds or plastic bags. Sowing must be superficial, with seeds in a vertical position and the acute end placed within the substrate. They must not be buried. They germinate well under different light regimes and are shade tolerant. Seedlings growing in the forest understory may be successfully transplanted to germination beds, plastic bags, or open areas in the field (Flores 1994f).

The species has been sporadically planted in experimental plots. A planting distance of 3 by 3 m has been used. Sapling growth and survival have not been carefully evaluated. In the forest, the seeds germinate well. The seedlings, saplings, and juveniles of all ages survive under the canopy, but their growth is slow especially during the first 2 years. Insect predation is intense. The species is a pioneer in the regeneration of disturbed areas; under natural regeneration it forms monospecific stands. Three factors may explain its colonizing capacity: nitrogen-fixing by root nodules (Allen and Allen 1981), precocious sexuality, and a series of accessory buds able to replace the damaged main shoot (Flores 1994f). The species appears suitable for natural regeneration and natural forest management.

ADDITIONAL INFORMATION

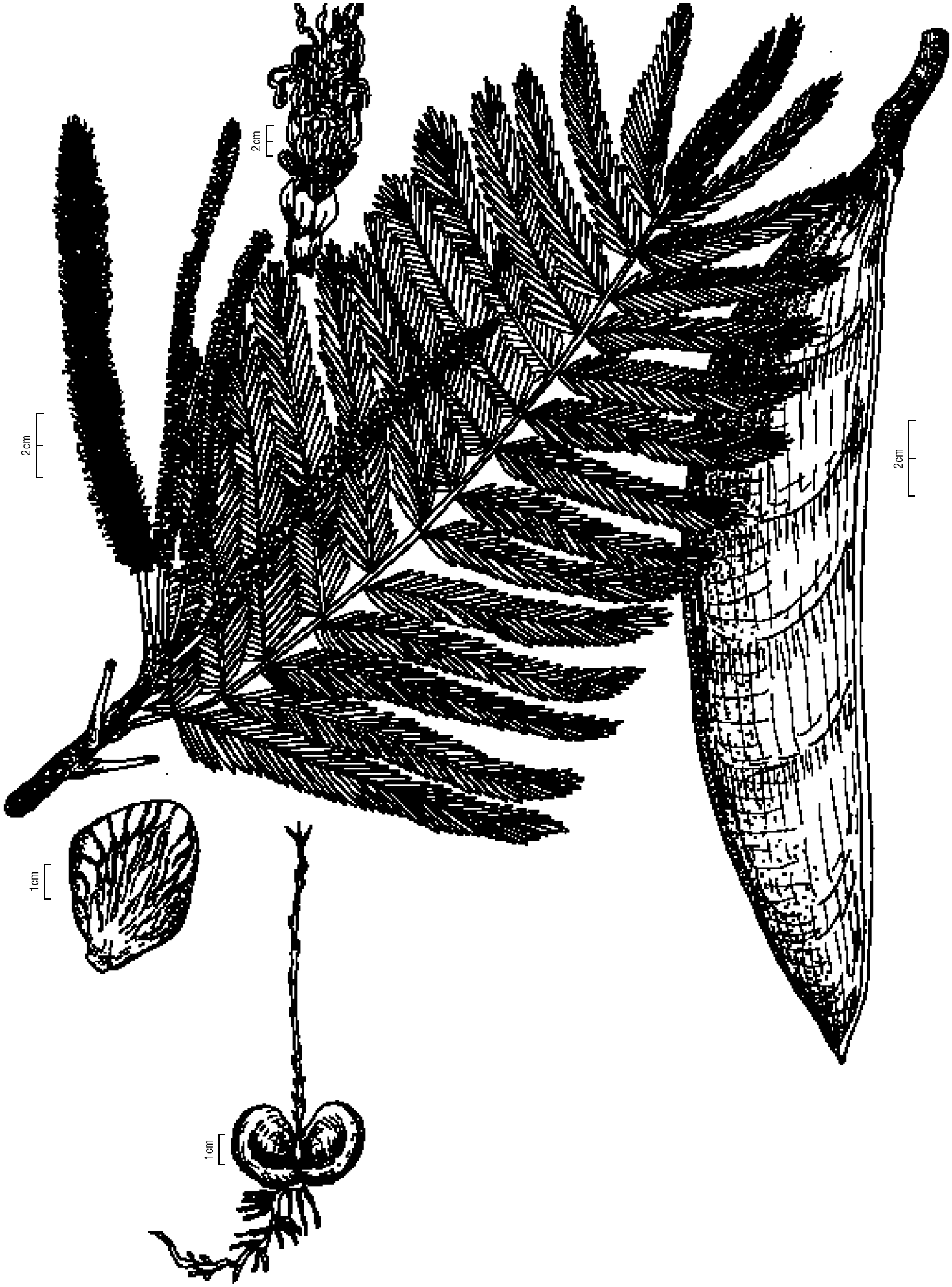
The genus name derives from the Greek roots *pente* (five) and *kleithron* (bolt). It refers to the valvate aestivation of the calyx lobes and to the petal concrescence at the basal third. The species name refers to the large and thick calyx lobes (Allen and Allen 1981, Flores 1994f).

The leaf's petiole is 1 to 7 cm long, pulvinated, semiterete, and adaxially sulcate. The leaf blade has 15 to 20 pairs of opposite pinnae, pulvinulated, and 2 to 10 cm long. The rachis may reach a length of 30 cm; it is pubescent and adaxially channeled. The numerous foliolules per pinna are opposite, semisessile, small, linear-subfalcate, 6 to 9 mm long, and 1 to 2 mm wide. Foliolules are entire with asymmetrical semilimbs and have pubescent margin, acute-acuminate apex, and an asymmetrical base that is oblique, round, truncate, or auriculated. The pinnules are hypostomatic, and the stomata are paracytic (Flores 1994f).

The calyx is cupuliform and purple, and the calyx lobes are pubescent, thick, broad, round distally, with imbricate aestivation, and 1 to 2 mm long. Petals are elliptic, 4 to 5 mm long, coherent at the basal third, pubescent, valvate, and purple but distally greenish. The stamens alternate with the sepals and five white staminodia; stamens are extrorse, white or yellowish, and basally fused to the staminodia. Filaments are filiform and 5 to 7 mm long; the anthers are 1 mm long and whitish, with a prominent distal gland. Anther dehiscence is longitudinal. Pollen grains are liberated in monads; they are triporate (with a diameter of 40 to 45 µm), exine smooth and without reticulum (Guinet 1978). The gynoecium has a conspicuous single style longer than the stamens; the stigma is wide and truncate. The ovary is subsessile, pubescent, free, and monocarpellar, with laminar placentation. It has several bitegmic anatropous ovules. The funiculus is short (2 to 3 mm long), thick, and restrained near the placenta (Flores 1994f).

The seeds lack endosperm and perisperm. The embryo is overgrown. The cotyledons are fleshy, thick, parenchymatic, oily, and slightly concave adaxially; they keep the asymmetry shown externally by the seed. The embryo axis is straight; the reddish plumule is well developed and bears several leaf primordia (Flores 1994f, Flores and Rivera 1989b). The auriculate base of the cotyledons encloses the small radicle.

The hypocotyl is vestigial. Plumule development is fast and may reach a length of 25 to 35 cm in 45 days (Flores 1994f). The seedling produces a spiral of 14 to 17 scales before it gives rise to the first biparipinnate leaf. The axil of each scale has two accessory buds in a descending series. The distal scale as well as the subsequent biparipinnate leaves have a series of three accessory buds. The series of accessory buds enhances the survival of seedlings and saplings (Flores 1994f).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