Rhizophora mangle L.

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RHIZOPHORACEAE (MANGROVE FAMILY)

Rhizophora mangle var. *samoensis* Hochr., *R. samoensis* (Hochr.) Salvoza

Mangle, mangle caballero, mangle colorado, mangle de chifle, mangle gateador, mangle injerto, mangle rojo, mangle salado, mangle zapatero, manglier, manglier rouge, mangro, mangue sapateiro, mangue vermelho, palétuvier rouge, red mangrove (Bohorquez 1996, Little and Wadsworth 1964)

The genus *Rhizophora* comprises six to eight species and three or four hybrids (Duke 1992, Tomlinson 1986). All members of this pantropical genus are considered true mangroves and are limited in distribution to the intertidal zone. The native range of *R. mangle* includes the coast of central and southern Florida, Bermuda and most of the West Indies, both coasts of continental tropical America from Mexico south to Brazil and northern Peru, and the coast of West Africa from Senegal to Angola (Chapman 1976, Little and Wadsworth 1964). *Rhizophora mangle* has also been introduced in several other locations, including Hawaii (Allen 1998) and Tahiti. *Rhizophora mangle* may also be native to western Pacific Islands from New Caledonia to American Samoa, but the taxonomic status of these populations is not completely clear and they have been treated both as a variety of *R. mangle* and as a separate species, *Rhizophora samoensis* (Tomlinson 1986).

Rhizophora mangle is a small to medium-sized tree of 10 to 20 m in height and 10 to 30 cm d.b.h. However, it may exceed 40 m in height and 70 cm d.b.h. on productive sites where hurricanes are infrequent. It is capable of moderately fast growth (1 to 1.5 m per year) on productive sites (Jimenez 1985). Its most characteristic feature is the mass of branched, arching, stilt (also called prop or aerial) roots, which may spread so profusely that they make *R. mangle* forests practically impenetrable. *Rhizophora mangle* is restricted to coastal environments, particularly low-energy, protected, intertidal sites with soft, muddy substrates. It also grows on other types of substrates, such as peat, marl, and sand, and occasionally on rocky and moderate-energy shorelines (Chapman 1976, Odum and others 1982). While salt-tolerant, its growth is impaired above about 35 parts per thousand (ppt) salinity, and mortality may occur above 60 ppt. The species grows in areas with average annual rainfall of about 800 to 10,000 mm per year and appears to be limited to areas with average temperatures of about 21 to 30 °C (Jimenez 1985). *Rhizophora mangle* often dominates the seaward side of mangrove forests, where it may form monospecific stands. Farther inland it more frequently mixes with other mangrove species (Odum and others 1982).

There is some controversy over the taxonomic status of *R. harrisonii*, which some consider a hybrid between *R. mangle* and *R. racemosa* (Jimenez 1985, Tomlinson 1986).

The wood of *R. mangle* is hard and very heavy, with a specific gravity of 0.9 to 1.2. The sapwood is light brown, and the heartwood is reddish brown or dark brown. The wood is used for pilings, posts, poles, cabinets, fuel, and charcoal and in shipbuilding. The wood is durable in the soil but susceptible to dry-wood termites (Little and Wadsworth 1964) and marine borers (Southwell and Bultman 1971). The bark has been used commercially as a source of tannin and various dyes and also to produce medicines (Little and Wadsworth 1964, Morton 1965).

Flowers are borne in axillary clusters, which have been characterized as simple cymes (*e.g.*, Wagner and others 1990) or as a modified dichasium (Gill and Tomlinson 1969). There are two to four flowers per cluster; typically clusters are three-flowered, with a terminal and a lateral pair of flowers, although the terminal flower is commonly absent (Gill and Tomlinson 1969). Flowers have a small, bell-shaped, pale yellow base (hypanthium); four widely spreading, leathery, and persistent pale yellow sepals approximately 10 to 15 mm long; and four narrow, downwardly curved petals that are initially whitish or pale yellow but turn brown. Flowers may be found throughout the year, but in southern Florida flowers are most abundant July through September (Gill and Tomlinson 1971).

Rhizophora mangle may begin flowering by 6 years of age, and possibly as young as 3 to 5 years; flowering has been reported in saplings as small as 0.5 to 1 m in height (Gill and Tomlinson 1969). Pollen appears to be dispersed primarily by wind (Tomlinson 1986, Tomlinson and others 1979).

Rhizophora mangle is viviparous, meaning that the species produces seeds that germinate on the parent plant. The dispersal unit, a viviparous seedling, is called a propagule. Following fertilization, from 4 to 7 months are required for emergence of the hypocotyl (Gill and Tomlinson 1971). Another 4 to 6 months typically elapse between appearance of the hypocotyl and abscission, by which time the propagule is between 8 and 30 cm in length. Fresh propagules range in weight from about 3 to 35 grams (29 to 333 per kg). Published mean weights of propagules include 7.8 g (scrub mangroves, Florida; Lin and Sternberg 1995), 13.1 g (tall mangroves, Florida; Lin and Sternberg 1995), 14.0 g (Panama; Rabinowitz 1978), and 23.3 g (Florida; Smith and Snedaker 1995).

Propagules can be collected directly from trees, from the ground, or from water surfaces. Propagules collected from trees should be fully developed and nearing abscission; these propagules usually detach from the pericarp with a gentle pull. Collected propagules should be bright green (except the lower portion, which is normally brown), have no roots or damaged plumules, and be free of other visible damage and/or discoloration (Bohorquez 1996, Snedaker and Biber 1996). Propagules with evidence of attack by the borer *Coccotrypes* (syn. *Poecilips*) *rhizophorae* (small emergence holes) should be discarded. Although propagules are available throughout the year, there is usually a pronounced peak of propagule availability. In Florida and the Caribbean, more propagules are available August through October (Padron 1996, Snedaker and Biber 1996).

Propagules may be stored for at least 3 to 4 weeks in moist containers (Snedaker and Biber 1996). Propagules stored indoors in open containers—with a small amount of water in the container and the propagules covered with moist paper towels—remained viable for 2 months (Crewz 1998). Experiments with storage of other *Rhizophora* species suggest that it may be possible to store *R. mangle* propagules for periods longer than 2 months. Kogo and others (1985), for example, reported better than 80-percent survival of *Rhizophora stylosa* propagules stored for 71 days in an air-conditioned room in closed plastic bags, in tap water and in 2- and 4-percent sea water. *Rhizophora mangle* propagules kept floating or submerged in water for up to 1 year have reportedly been grown successfully (Davis 1940).

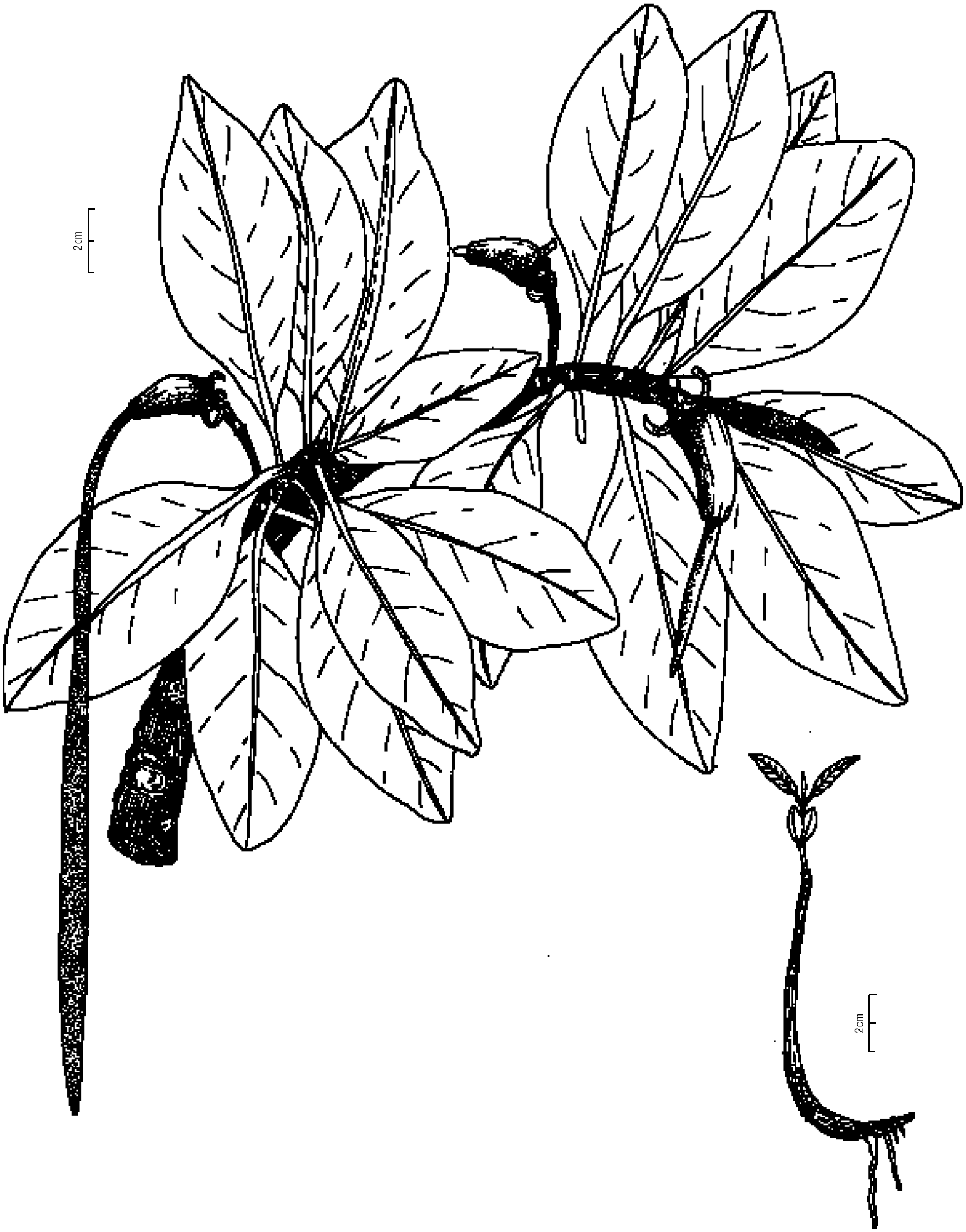
Germination without pretreatment may exceed 90 percent. Although pretreatment is unnecessary, the propagules can be soaked in water for 2 weeks or until root buds develop at the tip of the radicle (Crewz 1998).

In the nursery, *R. mangle* propagules are generally sown in tubes or small pots and grown under ambient conditions (Reark 1983). Keeping the pots half-filled with water prepares the seedlings for planting on anaerobic substrates and occasional watering with brackish or saline water (e.g., 15 ppt) will help to reduce subsequent planting shock on saline sites. Use of saline water may also help reduce the number of pathogens affecting seedlings in the nursery. Although easy to grow in nurseries, seedlings are occasionally damaged or killed by scales, aphids, caterpillars, wood/propagule borers, and fungal infections.

Seedlings of approximately 30 to 60 cm in height are produced after 1 year in the nursery and can be outplanted. Older, larger seedlings may be sold in 4, 12, 28, or even 40-liter containers.

Direct planting of propagules in the field is a low-cost method that has shown reasonably good success (Lewis 1990). Propagules are sown to a depth of about one-fourth to one-third of their length, although growth may be better when propagules are sown to a depth of only about 2.5 to 4 cm. Survival is best on well-protected, low-energy sites and in areas with low levels of propagule predation. On exposed sites or sites that frequently flood > 20 cm, direct sowing is more likely to fail. Planting large seedlings with well-developed root systems (Goforth and Thomas 1980, Snedaker and Biber 1996) or smaller seedlings within protectors, such as PVC pipes, may increase survival rates.

In all but the most northern parts of its range, *R. mangle* seedlings or propagules can be planted any time of the year, but cold and dry periods should be avoided (Snedaker and Biber 1996). The best time to plant nursery-grown seedlings produced without acclimation to salt water may be in seasonally rainy periods, which may reduce the shock caused by sudden exposure to high salinity (Barnett and Crewz 1989).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