Laguncularia racemosa (L.) Gaertn. f. White Mangrove

Combretaceae Combretum family

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HABITAT

Native Range

Laguncularia racemosa (L.) Gaertn. f. the white mangrove, is a common component of mangrove ecosystems along the tropical and subtropical coasts of North and South America and West Africa (fig. 1). On the Pacific coast of the Americas it is found from Ballenas Bay, Mexico (28°5′ N), to Punta Malpelo, Peru (3°40′ S) (*37*). On the Atlantic coast it is found from the Florida Peninsula (28°5′ N) to the Ararangua River, Brazil (29° S) (*9*).

White mangrove grows under a wide variety of conditions. It is generally found in the inner fringe of mangrove forests, on elevated soils where tidal inundations are less frequent and intense and in basin mangrove forests where tidal flushing is limited (*18*). In these areas, white mangrove is generally found associated with black mangrove (*Avicennia germinans* (L.) L.), where soil salinity averages 30 to 40 parts per thousand. In low salinity basins, the white mangrove is the dominant species. In riverine forests, white mangrove grows in low swales or point bar deposits generally associated with the red mangrove (*Rhizophora mangle* L.) (*31*).

Climate

White mangrove occurs in both tropical and subtropical climates. It can be found in tropical and subtropical dry, moist, and wet forest life zones where precipitation ranges from 800 to 7,000 mm per year (*28*).

Distribution appears to be restricted to those areas where the coldest average temperatures are above 15.5° C (*7*). White mangrove is the least tolerant to low temperatures of all the mangrove species (*27*), but in Brazil, white mangrove has the southernmost range among mangrove species (37). Under laboratory conditions, tolerance to low temperatures is higher than those of other mangrove species tested (*3, 21*). White mangrove is sensitive to frost.

Soils and Topography

White mangrove grows where water is salty or brackish. It is found growing in a broad range of soil conditions, from sandy soils to silty or clay deposits (*8, 31*). It has been observed in soft muds highly enriched with organic detritus and growing on fibrous peats overlying slightly oxidized clays (*31*). Rollet (*26*) reported white mangrove growing in peat deposits over 70 cm deep.

Though the species grows best on well-drained soils, it can occupy depressions where sheet flow and waterlogging are frequent. Chapman (*6*) reported white mangroves in areas inundated by 4 to 213 tides per year.

The species is salt-excreting and tolerates a broad range of soil salinities (0 to 90 parts per thousand) (*17*). It prefers soils with salt concentrations averaging 15 to 20 parts per thousand (*36*). At high soil salinities, over 50 parts per thousand, height growth is reduced.

Associated Forest Cover

White mangrove can be found growing in close association with all other mangrove species occurring within its range. Usually associated with species of the genera *Avicennia* and *Rhizophora*, it can be found on sandy berms associated with *Conocarpus erecta* L., but is seldom the dominant tree species except in low salinity basins (*8*).

Figure 1.—*Distribution of* Laguncularia racemosa *in the New World.*

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LIFE HISTORY

Reproduction and Early Growth

Flowering and Fruiting.—White mangrove has small, greenish-white pentamerous flowers, with 10 stamens and 2 ovate bracteoles. The flowers are supported on a terminal panicle or a solitary spike emerging from the leaf axil (*6*). Leaves are glabrous, obovate or elliptical, and characterized by the presence of a pair of glands at the base of the blade (*9*).

Flowering and seeding have been observed in plants less than 2 years old and 1.5 m tall (*11*). The fragrant flowers appear to be pollinated by insects. Production of flowers and fruits occurs year round (*20*). In the Caribbean area, fruit production peaks have been observed during September and October (*6*).

White mangrove fruit has an average weight of 0.4 g and an average length of 2.0 cm (*23*). There is a lower incidence of viviparity in these fruit than in those of other mangrove species. Normally the fruit drops from the parent tree and the radicle protrudes after a few days. Seedlings float and are water dispersed. Floating is aided by a thick pericarp. Fruits sink after a floating period of about 4 weeks, and growth begins while the seedling is submerged (*24*); establishment usually occurs in shallow water areas.

Seedling mortality is high (80 percent) during the first year of establishment (*8*). Rabinowitz (*24*) observed 100 percent mortality in a cohort of 100 seedlings 131 days after establishment. In the Caribbean, seedling densities of 0 to 3.6 seedings/m^2 (*1*), and 0.4 seedlings (19) have been reported. Establishment rates of 0.1 seedlings/$m^2 \cdot yr$ have been measured (*2*).

Vegetative Reproduction.—White mangrove coppices readily, but the sprouts are of poor form. Rapid early growth of sprouts has been reported in natural regeneration experiments. In one study, done during the first 3 years after clearcutting, 60 percent of the white mangrove stems were of sprout origin. However, seed-generated white mangroves outgrew the sprouts after the third year of growth (*33*).

Air-layering techniques have resulted in the successful production of roots and rootlets after 5 to 6 months (*4*).

Sapling and Pole Stage to Maturity

Growth and Yield.—White mangrove growth is characterized by a nonrhythmic, continuous growth of the meristems, e.g., Attim's architectural model (*10*). Growth is best in basin forests (fig. 2).

In the Caribbean area, white mangrove stands average between 10 to 15 m in height, but can exceed 25 m in height and 70 cm in diameter (*26, 30*). Net daytime primary productivity rates of 1.8 to 13.0 gC/m^2 day have been measured in Florida mangroves (*5*). The rate of net daytime photosynthesis changes with soil salinity and age of the stand. Gross primary productivity of white mangrove trees increases as chlorinity increases from 5 to 16 parts per thousand (*5*).

In a stand dominated by small saplings [6 m in height, 2.5 cm average diameter at breast height (d.b.h.)],

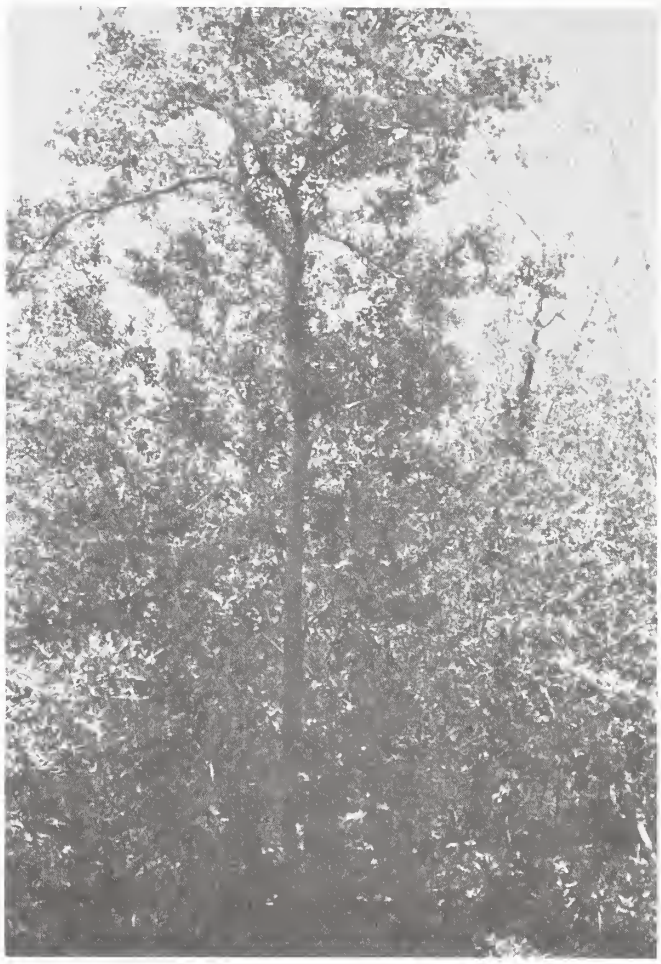

Figure 2.—*A* Laguncularia racemosa *tree, 11 meters tall.*

diameter growth averaged 0.1 cm per year. For codominant trees, average diameter growth was 0.3 cm per year. The stand had a density of 34,000 trees/ha, a basal area of 15.8 m^2/ha, and a volume of 41.2 m^3/ha. The mortality rate was 6 percent per year (*33*). In a stand with larger saplings (9 m in height, 4.3 cm average d.b.h.), diameter growth averaged 0.3 cm per year and 0.5 cm per year for codominants. These stands had a tree density of 22,500 trees/ha, a basal area of 33.3 m^2/ha, and a wood volume of 118.5 m^3/ha (*33*).

Certain stands have attained pole size (19 m in height, 12.5 cm average d.b.h.) at 22 years. The average diameter growth rate of these stands was 0.3 to 0.4 cm per year in codominant trees. Tree density values were 2,350 tree/ha with a wood volume of 200 m^3/ha. A mean annual net volume increment of 8.5 m^3/ha and a 5 percent mortality were reported (*33*). After a stand was clearcut in Puerto Rico, white mangrove grew faster than the black mangrove, *A. germinans* (table 1). Fastest growth rates were in the first 7 years (0.9 to 2.8 m^2/ha. yr). Periodic annual diameter increment after 37 years in three replicate stands were 0.48, 0.54, and 0.47 cm per year (*35*). A rotation system of 20 to 25 years is recommended for a d.b.h. of 12 to 17 cm at harvest (*11*).

Rooting Habit.—White mangrove is characterized by a shallow root system with large, spreading, horizontal

Table 1.—*Basal area growth in three Puerto Rican mangrove stands clearcut in 1937.* Avicennia *comprised between 2 to 6 percent of the stems in 1938 and between 20 to 30 percent in 1975*[1]

Time interval	*Laguncularia racemosa*	*Avicennia germinans*	Total
years	----------	m^2/ha. yr ----------	
1938–1945	....	....	0.18
	....	....	1.20
	....	....	1.48
1945–1949	2.8	0.44	3.24
	2.17	0.37	2.54
	0.92	0.29	1.21
1951–1955	0.77	0.58	1.35
	0.71	0.31	1.02
	0.63	0.48	1.11
1955–1975	0.67	0.08	0.75
	0.94	0.12	1.06
	0.71	—0.04	0.67

[1] Data adapted from Weaver 1979 (35).

roots. From these horizontal roots an underground and aboveground subsystem of peg-roots develops. These peg-roots appear to occur only in areas influenced by particular tidal fluctuations (*16*). Peg-roots are club-shaped and their terminal heads contain ventilating tissue. This type of ventilating root is typical of species growing in flooded soils (*15*). In individual white mangroves growing in basin forests, aerial adventitious roots sometimes emerge from the lower section of the trunk (*26*).

Reaction to Competition.—White mangrove is considered intolerant of shade (*36*). Regeneration under a closed canopy is inhibited (*23*). Thinning of stands fails to produce effective natural regeneration. However, clearcutting of strips 20 m wide, oriented perpendicularly to the prevailing winds, has provided abundant saplings up to 5 m in height after 2 years (*13*).

Planting of natural seedlings 0.6 m tall at 2.5 m spacings resulted in good survival and growth (*11*). Transplanting of pruned saplings (0.5 to 1.5 m tall) resulted in faster growth rates; height was increased 1.3 times (37 cm per year) faster than unpruned saplings (*22*).

Thinning practices, designed to reduce stagnation of young stands, have not produced significant results. Eighteen-year-old, unthinned stands had the same average d.b.h. (6.5 cm) as previously thinned stands (6.4 to 6.7 cm; *13*). Heavy thinning can result in considerable windthrow damage (*14*).

Damaging Agents.—The wood-borer, *Sphaeroma terebrans* Bate, has been reported in white mangroves of south Florida (*25*). Tree mortality, related to the beetle *Chrysobothris tranqueborica* Gmelin. and the borer *Psychonoctua personalis* Grote, has been observed in white mangrove stands of Puerto Rico (*12*). Due to its shallow root system, white mangrove is highly susceptive to windthrow.

SPECIAL USES

White mangrove is extensively used as a source of fuel and charcoal in tropical coastal areas. Because trees rarely reach sawtimber dimensions, they are mainly used for posts and poles. The usually large number of trees in the pole stage makes this a practical use for the species. Fence posts last only 18 to 30 months in the ground if they are not treated. If treated with nonpressure preservatives (hot and cold baths), they may last more than 10 years (*33*).

The wood of white mangrove is a dark greenish brown, with a moderately fine texture. It has a specific gravity of 0.7 to 0.8 (*29*). There is little shrinkage after air-drying, and the wood is resistant to dry-wood termites (*32*). However, white mangrove wood is heavily damaged by marine borers, and this limits its use in marine pilings (*29*).

The bark and leaves contain between 10 to 24 percent of their dry weight as soluble tannins. Both have been used in tannin factories (*34*). White mangrove bark is also used for medicinal purposes. Infusions from the bark are generally used as astringents and tonics (*32*).

LITERATURE CITED

1. Ball, Marilyn C. 1980. Patterns of secondary succession in a mangrove forest of southern Florida. Oecologia 44:226–235.
2. Banner, A. 1977. Revegetation and maturation of restored shorelines in Indian River. *In* Proceedings, fourth annual conference on restoration of coastal vegetation in Florida, Environmental Studies Center, Hillsborough Community College, Tampa, FL. p. 13–44.
3. Biebl, R. 1965. Temperaturresistenz tropischer Pflanzen auf Puerto Rico. Protoplasma, Leipzig 59:133–156.
4. Carlton, Jedfrey M., and Mark D. Moffler. 1978. Propagation of mangroves by air-layering. Environmental Conservation 5(2):147–150.
5. Carter, Michael R., Lawrence A. Burns, Thomas R. Cavinder, Kenneth R. Dugger, Paul L. Fore, Delbert B. Hicks, H. Lavon Revells, and Thomas W. Schmidt. 1973. Ecosystems analysis of the Big Cypress swamp and estuaries. U.S. Environmental Protection Agency, Atlanta, GA. EPA 904/9–74–002.
6. Chapman, V. J. 1944. 1939. Cambridge University expedition to Jamaica. Journal of the Linnean Society of London 12:407–533.
7. Chapman, V. J. 1975. Mangrove biogeography. *In* Proceedings of the International Symposium on Biology and Management of Mangroves. Walsh, Gerald, Samuel C. Snedaker, and Howard Teas, editors. University of Florida, Gainesville. p. 3–22.
8. Davis, John H. 1940. The ecology and geologic role of mangroves in Florida. Papers of the Tortugas Laboratory (Carnegie Institution) 32:303–412.
9. Graham, Shirley A. 1964. The genera of Rhizophoraceae and Combretaceae in the southeastern United

States. Journal of the Arnold Arboretum 45(3): 285–301.
10. Halle, F., R. A. A. Oldeman, and P. B. Tomlinson. 1978. Tropical trees and forests: an architectural analysis. Springer-Verlag, New York. 441 p.
11. Holdridge, L. R. 1940. Some notes on the mangrove swamps of Puerto Rico. Caribbean Forester 1(4): 19–29.
12. Institute of Tropical Forestry. 1950. Tenth Annual Report. Caribbean Forester 11(2):59–80.
13. Institute of Tropical Forestry. Fourteenth Annual Report. Caribbean Forester 15(1/2):1–13.
14. Institute of Tropical Forestry. 1956. Sixteenth Annual Report. Caribbean Forester 17(1/2):1–11.
15. Jenik, J. 1970. Root system of tropical trees. 5. The peg-roots and the pneumathodes of *Laguncularia racemosa* Gaertn. Preslia Prague 42:105–113.
16. Jenik, Jan. 1978. Roots and root systems in tropical trees: Morphologic and ecologic aspects. *In* Tropical trees as living systems. P. B. Tomlinson and Martin H. Zimmermann, editors. Cambridge University Press, Cambridge. p. 323–349.
17. Jimenez, Jorge Arturo. 1981. The mangroves of Costa Rica: a physiognomic characterization. Thesis, MS, University of Miami, Coral Gables, FL. 130 p.
18. Lugo, Ariel E., and Samuel C. Snedaker. 1974. The ecology of mangroves. Annual Review of Ecology and Systematics 5:39–64.
19. Lugo, Ariel E., Robert R. Twiley, and Carol Patterson-Zucca. 1980. The role of mangrove forests in the productivity of coastal ecosystems in south Florida. Final report to U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, Corvallis, OR. Contract No. R 806079010. Center for Wetlands, University of Florida, Gainesville. 281 p.
20. Marshall, R. C. 1939. Silviculture of the trees of Trinidad and Tobago, British West Indies. Oxford University Press, London. 247 p.
21. McMillan, Calvin. 1975. Adaptative differentiation to chilling in mangrove populations. *In* Proceedings of the International Symposium on Biology and Management of Mangroves. Walsh, Gerald, Samuel C. Snedaker and Howard Teas, editors. University of Florida, Gainesville. p. 62–68.
22. Pulver, Terry R. 1976. Transplant techniques for sapling mangrove trees, *Rhizophora mangle, Laguncularia racemosa,* and *Avicennia germinans* in Florida. Florida Marine Research Publications 22:1–14.
23. Rabinowitz, Deborah. 1978a. Mortality and initial propagule size in mangrove seedlings in Panama. Journal of Ecology 66:45–51.
24. Robinowitz, Deborah. 1978b. Dispersal properties of mangrove propagules. Biotropica 10(1):47–57.
25. Rehm, Andrew E. 1976. The effects of the woodboring isopod *Sphaeroma terebrans* on the mangrove communities of Florida. Environmental Conservation 3(1):47–57.
26. Rollet, B. 1974. Introduction a l'etude des mangroves du Mexique. Bois et Forests des Tropiques 156:3–26.
27. Savage, Thomas. 1972. Florida mangroves as shoreline stabilizers. Florida Department of Natural Resources, Marine Research Laboratory Professional Papers 19:1–46.
28. Schwerdtfeger, Werner, editor. 1976. Climates of Central and South America. World Survey of Climatology. Volume 12. Elsevier Scientific Publishing Company, Amsterdam. 532 p.
29. Southwell, C. R. and J. D. Bultman. 1971. Marine borer resistance of untreated woods over long periods of immersion in tropical waters. Biotropica 3(2): 81–107.
30. Taylor, B. W. 1963. An outline of the vegetation of Nicaragua. Journal of Ecology 51(1):27–54.
31. Thom, Bruce G. 1967. Mangrove ecology and deltaic geomorphology. Tabasco, Mexico. Journal of Ecology 55:301–343.
32. Uphof, J. C. 1968. Dictionary of economic plants. Verlag von J. Cramer, Germany. 591 p.
33. Wadsworth, Frank H. 1959. Growth and regeneration of white mangrove in Puerto Rico. Caribbean Forester 20(3/4):59–71.
34. Walsh, Gerald E. 1977. Exploitation of mangal. *In* Ecosystems of the world. Volume 1. Wet coastal ecosystems. V. J. Chapman, editor. Elsevier Scientific Publishing Co., Oxford. p. 61–67.
35. Weaver, Peter L. 1979. Tree growth in several tropical forests of Puerto Rico. U.S. Department of Agriculture, Forest Service Research Paper SO-152. Southern Forest Experiment Station, New Orleans, LA. 15 p.
36. Weishaupl, Liane. 1981. Plantas de Mangue: contribuicao ao conhecimento de *Laguncularia racemosa* (L.) Gaertn. Thesis, MS, Instituto de Biociencias. University of Sao Paulo, Brazil. 157 p.
37. West, Robert C. 1977. Tidal salt-marsh and mangal formations of middle and south America. *In* Ecosystems of the world. Volume 1. Wet coastal ecosystems. V. J. Chapman, editor. Elsevier Scientific Publishing Co., Oxford. p. 347–362.