This chapter reviews how hydraulic architectures of tropical trees and lianas (woody vines) influence the flow of water from roots to leaves. The hydraulic design potentially can limit plant water relations, gas exchange, successional distribution, and even the maximum height (or length, in the case of lianas) that a species can attain. Important parameters include vulnerability to drought-induced cavitation (since embolism reduces hydraulic conductance), root pressures (since these potentially could result in re-filling of conduits following cavitation events, thereby increasing conductance), leaf specific conductivity (which, together with transpiration rates, can predict pressure gradients throughout the plant), and water storage capacity (since this might determine the ability to survive water shortage). Some of the issues that are dealt with here are the impact of vessel diameter on drought- and freezing-induced embolism, the role of root pressures in the occasional removal of embolisms, and the ways in which the hydraulic architecture differs in different growth forms such as trees.
shrubs, lianas, and hemiepiphytes. The ecological and physiological trade-offs of different architectures are discussed, and comparisons are made with temperate plants.

8.1 WATER RELATIONS AND HYDRAULIC ARCHITECTURE

Water deficits are created in plants when water loss by the leaves is greater than water absorption by the roots. The structure of the water conductive system (the hydraulic architecture) can potentially limit the flow of water to leaves and thus it can limit leaf water potential, stomatal behavior, and gas exchange. Since we recently reviewed hydraulic architecture in woody plants (Tyree & Ewers, 1991), as well as xylem structure and water flow in vines (Ewers, Fisher & Fichtner, 1991), in this review we provide only a brief overview of the concepts of hydraulic architecture. We focus our attention on tropical woody plants and provide some new information on the structure and function of root systems in relation to hydraulic architecture.

8.1.1 Parameters used to describe hydraulic architecture

8.1.1.1 Hydraulic conductivity ($k_h$)

Hydraulic conductivity per unit pressure gradient ($k_h$) is equal to the ratio between water flux ($F$, kg s$^{-1}$) through an excised stem segment and the pressure gradient ($dP/dx$, MPa m$^{-1}$) causing the flow:

$$k_h = F/(dP/dx) \quad (1)$$

To determine the relationship of $k_h$ to the hydraulic architecture of woody plants, it can be divided by the cross-section of the functional xylem (sapwood) in the segment or by the leaf area distal and/or attached to the segment.

8.1.1.2 Specific conductivity ($k_s$)

Specific conductivity ($k_s$), which is a measure of the porosity of the wood, is equal to $k_h$ divided by the sapwood cross-sectional area ($A_s$, m$^2$). By Poiseuille’s law for ideal capillaries, specific conductivity will