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Sap Flow

Understanding sap flow in trees is quite important for anybody who is attempting slightly adventurous bonsai techniques, and the biology behind it should be of interest to all gardeners. The following explanation is a very simplified and general description of plant structure. The details vary considerably from primitive trees like conifers to the more recently evolved deciduous and flowering species but the principles remain the same.

About the only things I remember from my high school botany lessons were the words Xylem and Phloem and probably because of the strange spelling, I certainly did not have much of a grasp of the roles they play in the life of plants. Even very knowledgeable bonsai growers will avoid the question and say something vague like, ? Oh, they have something to do with transporting water and plant food, but don't ask me which does what.?

So, here at last, is the low down and dirty on Xylem and Phloem.

Consider the stump of a freshly chopped down tree (probably a rare and soon to be extinct variety). The bulk of the wood or the concentric rings in the center is dead wood and is purely there to support the rest of the tree. You have seen how trees can grow unhampered with hollowed out trunks. The outer areas of the dead wood consist of vertical bundles of tubes that lead up from the roots to the leaves. These tubes are the Xylem and they transport water and minerals up to the leaves. The leaves combine the minerals and sugars created by photosynthesis to form amino acids, the raw building materials for the plant. These amino acids dissolved in water, commonly referred to as sap, are transported to all growing areas of the plant via the Phloem.

The Phloem consists of long thin cells up to 1 mm in length. They butt up end to end and have porous cell walls which allow the sap to move horizontally as well as vertically. As the tree grows the cell walls of the Phloem break down, and the structure eventually becomes Xylem. Phloem is living tissue and Xylem is dead.

Phloem and Xylem are normally positioned close together, sometimes in bundles called vascular bundles (the veins of leaves) and sometimes as a continuous ring between the green cambium and the Xylem. In most cases though, the Phloem is closer to the surface than the Xylem.

A day in the life of a tree begins with sunrise. Moisture in the leaves is evaporated by the sun (transpiration), resulting in there being less water in the leaves than the roots. Because liquids tend to move from a high concentration to a low concentration the water is sucked up the Xylem to the leaves where the chemistry is performed. The leaves now have a high concentration of sap but because the sap is thicker than water it cannot escape through the leaves and is forced into the Phloem which then distributes it to all parts. As the sun sets transpiration ceases and the tree goes to sleep. Some trees like acacia can close their leaves to control the amount of transpiration and so conserve water on a very hot day.

A bonsai grower can use the above information in a variety of subtle ways to influence the shape and design of trees.

A small horizontal cut just below a branch will obstruct the sap's downward path to the roots (Phloem), without cutting off the upward supply of water (Xylem). This will result in a build-up of sap at the base of the branch and with nowhere else to go the sap will move into the side branch resulting in a growth surge in that area. This will in turn reduce the amount of sap in the area directly below the cut. This will have an effect on the lower area but if performed with caution any adverse effects can be kept to a minimum. By the way, this is the exact reason why the rules of bonsai suggest that no branch should be directly above another. Eventually the top branch will starve the lower and it will die off.

In next month's issue I will explore various ways one can use sap flow to correct problematic areas in trees.