The Mystery of Tree Leaves

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I've been looking at a lot of leaves lately and love the diversity of shapes. They range from the large lobed leaves of my Bur Oak to the classic maple shape found on the Canadian flag to the glossy, fluttering leaves of mountain aspens. I used to love picking colorful fall leaves, ironing them between sheets of waxed paper and pasting them on construction paper. Perhaps that's why I love the new Alamosa Trees logo created by Jennifer Roddam of ConsciouslyClearDesigns.com. See the logo at AlamosaTrees.net!

But why are there so many shapes and sizes of leaves? In fact, some tree species grow two or more leaf shapes on a single tree. Obviously, one size does not fit all.

I thought in this scientific age I'd easily find a clear explanation. Turns out there's a lot we don't know about leaves. Who knew I'd find a mystery in leaves?

Let's start with what is observable and known. You might want to grab a few different leaves before reading further. Have you noticed the difference between houseplant leaves and deciduous tree leaves? Many houseplants come from tropical forests where plants retain their leaves for years. They're thicker and sturdier. Thinner leaves require less energy to produce and are more effective at photosynthesis.

However, there is a cost of having thinner leaves: they are not as sturdy, particularly in areas distant from the major leaf veins (which provide structural support for the leaf). Conceivably, the less efficient leaf areas disappeared, resulting in lobed leaves like those of the Gambels or Bur oak. The lobes (or teeth) of many leaves of Colorado plants also help to reduce wind resistance (and the damage that could result). Toothed leaves permit sunlight to reach leaves beneath them, perhaps another advantage in the forest.

Cast your mind back to high school botany when you learned about the basic functions of tree leaves. 1-A leaf transports resources like water and nutrients from its root to its tissues via xylem (the supporting and water-conducting tissue of vascular plants). 2-The leaf absorbs solar energy (which may heat up the leaf) at its cells through photosynthesis. It takes in carbon dioxide (resulting in carbon sequestering) from the surrounding air through pores called stomatae. When the stomatae open to intake carbon dioxide, the leaf loses water to the environment.

3-Then the leaf transports the chemical products (carbohydrates) synthesized in the leaf back to its root via phloem (tissue between the cambium and bark). The leaf undergoes a balancing act: enough sunlight and carbon dioxide to run photosynthesis, but not too much heat absorption or water loss.

Scientists suggest that a leaf tends to increase its surface area as large as possible to maximize its ability to produce energy from the sun while maximizing its internal efficiency to transport water to leaf cells and export created energy.

Leaves high in the tree canopy receive a great deal of sunlight. These leaves tend to be smaller in size and tend to have complex edges and lobes. Leaves in the lower tree canopy are more shaded. These lower canopy leaves tend to be larger and tend to have simpler shapes. Compare the lobed leaves of high canopy trees (such as oaks) to the smoother leaves of low canopy trees (like dogwoods). The same thing can be observed in an individual tree that has leaves in both the upper and lower canopies (the white oak, for example).
The above gives a general idea of leaf variation, but doesn't account for the wide range of diversity. Recently, two scientists (Benjamin Blonder of the University of Arizona and Qinglan Xia of the University of California at Davis) independently applied mathematical modeling of transportation systems to the problem with promising results.

At the risk of oversimplification, it's all in the geometry of the veins. It's a business proposition really. The veins transport water and other nutrients from the roots to the leaves and then transport energy from the leaves to the rest of the tree. Transportation can be costly (have you used UPS lately?). Suppose a tree leaf creates more energy-producing cells at its boundary. Does this out weight the cost of transporting the energy to the rest of the tree? If it doesn't, why create addition cells there?

With this idea in mind, the scientists vary inputs and the computer model "grows" leaves that are very similar to real-world leaves. The mathematical models are very complex but you can view graphics of computer-generated leaves by Googling Qinglan Xia's website.

For me, I think I'll go sit in the shade of a tree and enjoy its gently swaying canopy before the fall winds take the leaves.

"No shade tree? Blame not the sun but yourself." Chinese proverb